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THE LIFE OF THE ANT

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MAURICE MAETERLINCK

WITHDRAWN

The LIFE *of the* ANT

TRANSLATED BY
BERNARD MIALL

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MARSHALLTOWN, IOWA 50158
830550

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ABOUT THE AUTHOR

MAURICE MAETERLINCK was born at Ghent, Belgium, on August 29, 1862. He was educated at the Collège Sainte-Barbe and the University of Ghent, and with the exception of a few years in Paris as a young man, most of his life has been spent in Belgium—winters at Ghent, summers on his beautiful estate at Oostacker.

M. Maeterlinck is the author of innumerable plays (of which the best known in this country are probably *The Bluebird* and *Pelléas and Mélisande*), books of essays, some translations and two volumes of verse. His plays are noted for their mystic quality, and their effective use of symbols to indicate emotions too subtle for direct expression. In his unique studies of the social insects: the bee, the termite (or white ant) and the ant, he conveys not only accurate pictures of his subjects, but a rather remarkable development of his own philosophy.

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CONTENTS

INTRODUCTION	3
GENERAL IDEAS	21
THE SECRET OF THE FORMICARY	45
THE FOUNDING OF THE COMMUNITY	63
THE NEST	83
WARFARE	103
COMMUNICATION AND ORIENTATION	137
PASTORAL ANTS	167
THE MUSHROOM-GROWERS	179
AGRICULTURAL ANTS	197
PARASITES	229
EPILOGUE	251
BIBLIOGRAPHY	273

INTRODUCTION

INTRODUCTION

I

MORE than once I have been asked why I did not complete the triptych of the social insects, the first two panels of which, *The Life of the Bee* and *The Life of the White Ant*, have been favorably received by the public. For a long while I hesitated. I felt that the ant was an ungrateful subject, too familiar, and antipathetic. It seemed to me of little use to repeat the statements as to its intelligence, industry, diligence, avarice, foresight and policy which form part of the common patrimony that we acquire in the preparatory school, and which linger in our memories beside such fragmentary historical incidents as the battle of Thermopylæ or the siege of Jericho.

Having lived always more in the country than in towns, I was naturally interested in this

inevitable insect. At one time I used even to keep ants in glass-topped boxes, and without any special purpose or method I observed their busy comings and goings, which did not teach me very much.

Since then, returning on my steps, I have realized that in respect of the ant—as indeed in respect of everything on earth—while we think we know everything we really know hardly anything; and the little that we do learn tells us, at all events, how much remains to be learned.

Above all, it enables us to realize the difficulties of the task. The hive or the termites' nest is all of a piece, and we can examine it from any angle. We can speak of a typical hive, a typical bee, a typical termitary, whereas there are as many kinds of ants' nests as there are species of ants, as many different modes of life as there are species. One can get no hold upon one's subject; one does not know at which point it is best attacked. The material available is too rich, too vast: its ramifications are endless; we

soon lose our way, and our interest is dispersed in all directions. Unity is impossible, for there is no center. We find that we are writing, not the history of a family or a community, but the annals, or rather the ephemeral chronicles, of a hundred different nations.

Add to this that so soon as we take the first steps we are likely to lose our footing in the literature of myrmecophily. It is as abundant as the literature of apiculture, and of this, in the entomological bureau of Washington, there are more than twenty thousand examples. The bibliographical index given by William Morton Wheeler at the end of the volume entitled *Ants* would fill half of this book. It is far from complete, for it does not include the publications of the last twenty years.

II

We must therefore observe certain limits, and we must allow ourselves to be guided by the leading authorities. Without lingering over

the precursors—Aristotle, Pliny, Aldrovandi, Swammerdam, Linnæus, William Gould, and De Geer, to name no more—let us loiter for a moment beside the veritable father of myrmecology: René-Antoine Ferchault de Réaumur.

He is the father of the science, but a father unknown to his children. The rough draft of his *Histoire des Fourmis*, buried amidst his later manuscripts, was mentioned by Flourens, in 1860, and then completely forgotten. The great American myrmecologist, William Morton Wheeler, professor of entomology in Harvard University, rediscovered it in 1925, and in the following year published, in New York, the French text accompanied by notes and a translation. This *History of the Ants* had no influence whatever on the entomologists of the nineteenth century, but it deserves to be noticed, since it may be read with profit, and not without pleasure, for Réaumur, who was thirty-two years of age when Louis XIV died, wrote the French of the great period. We find in it, in

the germ, and often in something more than the germ, that is, in the almost perfect state, a certain number of observations which were until recently accepted. This little treatise, which, as a matter of fact, was never completed, and contains only a hundred pages, revived, or rather reëstablished the science of myrmecology as we understand it today.

It begins by destroying a number of legendary beliefs and prejudices which had obscured the approaches to the formicary since the days of Solomon, and St. Jerome, and the Middle Ages. Above all, he conceived the idea of keeping ants in what he calls "pounce-boxes," which were, according to his own description, "bottles of glass like those found in the cabinets of connoisseurs, of which the mouth has almost the same diameter as the base," thereby inaugurating the artificial nests which since his day have been of such service to entomologists. He states that the ant—and experiment has confirmed the statement—is able to live without food in moist

earth for nearly a year. He understands the importance and the significance of the nuptial flight, and is the first writer to explain why the females have wings, which they suddenly discard after their union is consummated; whereas the older naturalists were convinced that the female ant grew wings only in her old age, as a sort of consolation, so that she might die with greater dignity. Anticipating Gould, he notes the manner in which a fertilized queen founds a colony. He writes of the laying of the eggs, and more than suspects the endosmosis which is the key to the inexplicable enigma of their growth. He describes how the larva or nymph begins its cocoon, whose fabric, as he remarks, "consisting of several layers of thread, adhering to one another, is so compact that one would take it to be a membrane if one did not know how it had been constructed." He does not omit to note the regurgitation which is, as we shall see, the essential and fundamental act of the formicary. He even has some intuition of the

phototropisms which play so important a part in the early manifestations of life; and after falling into a few unimportant errors, he makes one, and only one serious mistake: he confounds the ants with the termites; but this confusion was in his day almost inevitable, and the distinction was finally established only at the close of the eighteenth century.

III

Since abridgement is here unavoidable, we must regretfully pass over the myrmecologists of the intervening period—Leuwenhoeck, who dealt with the metamorphoses of ants, Latreille, who made the first tentative classifications, Charles Bennet, the great naturalist and philosopher, who discovered the parthenogenesis of the plant-lice, the cattle of the ants, and many others—to pass on at once to contemporary myrmecology.

First of all we salute Pierre Huber, the son of François Huber, the historian of the bees;

both are citizens of Geneva. Their compatriot, Auguste Forel, who is entitled to judge, since with Wasmann, Wheeler, Emery and a few others he is one of the great myrmecologists of the day, declares that Pierre Huber's *Les Recherches sur les Mœurs des Fourmis Indigènes* is "the Bible of myrmecology." He does not exaggerate; it is a work in which only its delightful prolixity seems a little out of date. It enjoyed great success at the time of its publication, and was hotly attacked, but its minute and almost fatherly observations of the Grey-Black Ant, the Miner Ant, and the Amazon, which in his day bore these familiar names, and have since become the *Pratensis*, *Rufibarbis* and *Polyergus rufescens* of science, have endured more than a century of criticism, and have not been found wanting. For that matter, he began with an admirable principle, of which he never lost sight, and which has become the fundamental rule of entomology: "The more I am attracted by the marvels of nature, the less

am I inclined to spoil them by alloying them with the fantasies of the imagination."

If, as Forel says, *Les Recherches sur les Mœurs des Fourmis Indigènes* is the Bible of myrmecology, Forel's own work, *Les Fourmis de la Suisse*, is the *Summa*. The second edition, in particular, published in 1920, is the veritable encyclopædia of the ant, in which nothing has been forgotten. But it has the defects of its qualities; in other words, it is too densely packed; one cannot see the wood for the trees, and one ends by losing one's way. On the other hand, the sureness and exactitude of M. Forel's observations, and the breadth and integrity of his erudition are beyond criticism. It is hardly possible to speak of the ant without owing to him at least a third of what one says. It is true that he himself owes two-thirds of what he tells us to other specialists. Thus it is that science progresses, overflowing in all directions the too brief life of man; or, if you prefer, it is thus that history progresses, for myrmecology, after

all, is but the history of a strange and unfamiliar race. Like all histories, it compels us frequently to retrace its record, to go back to its starting-point, and ten successive human lives would not suffice to assemble and combine all the observations which are today at our disposal, and which are the fruit of nearly two hundred years' labor. But one thing we may endeavor to do: to extract, from these countless little data, apparently so dissimilar and incoherent, a meaning and a general idea. It is easier, however, to make the attempt than to succeed.

After Forel comes Wasmann, a German Jesuit, whose name recurs on every page of the history of the ant. He turned his attention more especially to the study of the slave-holding races, and devoted thirty years to studying the parasites of the ants' nest—a subject, as we shall presently see, of truly formidable dimensions. He is an admirable observer, whose patience and lucidity are exemplary.

The mere list of his books, pamphlets and articles would occupy a dozen pages of this volume. They have only one defect: when explanation becomes difficult the theologian or the casuist gets the better of the scientist, and goes out of his way to excuse or glorify a God who is too manifestly the deity of the Jesuits.

In the work of William Morton Wheeler, it is not theology but human thought which is blended with, and gives life to, the purely objective science of the entomologist.

As an observer, Wheeler is no less scrupulous than Forel and Wasmann; but as a thinker he sees farther and probes more deeply, and derives from what he has seen reflections and general ideas of greater scope than those of his colleagues.

I must not forget to mention the engineer Charles Janet, whose innumerable treatises, monographs and communications to learned societies—clear, precise and impeccable, and adorned by anatomical plates which have be-

come classic—have for nearly fifty years enriched myrmecology as well as many other sciences. He is one of those great workers to whom justice is done only when they are dead.

Above all, we must not forget the Italian, C. Emery, the great classifier, who has devoted himself to the dry and ungrateful but necessary task of establishing the minute and technical description—the myrmecological catalogue, so to speak—of most of the ants, in order that they may be accurately identified. It is probable that good photographs in natural colors, with enlargements of details, will in time take the place of these descriptions, which are almost as deceptive as the descriptions on passports. Other specialists, notably Bendroit and Ernest André, have applied themselves to the same task. Ernest André, moreover, is the author of the only popular and easily accessible monograph in the French language. Unfortunately it is somewhat out of date, having appeared nearly fifty years ago; that is, at a time

when Forel had only just published his first version of the *Fourmis de la Suisse*, and when Wasmann and Wheeler were beginning their labors. He was not familiar, for example, with the fungus-growing ants, which in his day were known as the Leaf-cutter Ants, since it was believed that the only use they made of the segments which they cut from leaves was to line their tunnels with them. He knew nothing of the extraordinary Weaver Ants; nor of the latest observations of the Visiting Dorylinus, nor of the interesting experiments relating to the olfactory sense and the power of orientation, nor of the tragic manner in which a colony is founded. On the other hand, he accepts, perhaps too readily, though not without reserve, certain sentimental imaginings relating to the cemeteries of our fossorial hymenoptera, their cult of the dead, their funeral processions, their first-class interments, their concessions to perpetuity, and the like; whereas they do no more than get rid of corpses as promptly as possible,

carrying them out of the nest; and while they do not devour them, as the termites do, this is probably because they would not be able to digest them, rather than because of any delicacy of feeling.

IV

But further enumeration would become tedious. Other names will occur in the following pages, and will be found, at the end of the volume, in a bibliography which is necessarily brief, but which comprises all that is really essential.

It will perhaps be said that these hundreds of scientists, by no means the least of their profession, who might have done so many other things of a more profitable nature, have wasted a great deal of time and taken a great deal of trouble to observe the habits and discover the petty secrets of some very insignificant creatures. But where the mysteries of life are concerned nothing is insignificant. All creatures, great and small, are on the same plane, and

equally important; and the astronomer works on the same plane, and with the same material, as the entomologist.

There is no hierarchy in the sciences, and myrmecology is a science, and one which approaches more closely than many others the subtler contours of the most tragic and baffling problems. From a certain point of view the meanest ant-hill, a replica *in petto* of our own destinies, is more interesting than the most formidable congeries of extragalactic nebulæ, even though this contain millions of stars thousands of times larger than our own sun. It may perhaps help us to decipher, a little sooner and more effectually, the thoughts and the afterthoughts of nature, and certain of her secrets, which are everywhere identical, whether on the earth or in the heavens

In order that we should really be interested —as it is just and necessary that we should be— in lives which are not on the scale of our own, let us imagine that we are considering the his-

tory of a pre-human race, which lived and died some thousands or millions of years before our own advent. We have no means of knowing that such a race may not have existed, just as we have no means of knowing that a post-human race will not arise some thousands or millions of years after our departure. In the infinity of time the past and the future are interchangeable.

GENERAL IDEAS

GENERAL IDEAS

I

LET us, to begin with, recapitulate as briefly as possible a few elementary data which it will be well to keep in mind. The ants are aculeate hymenoptera, fossorial and social. Up to the present time six thousand species have been described, and all these species have their own habits, their individual characters. For that matter, it is probable that a less conventional method of classification would double this number. But we will not venture into the jungle of the entomological classification into families, sub-families, species, races or sub-species, tribes and sub-tribes; such an excursion would take us too far afield, and after all the subject is not one of any real interest. Let us be content to follow Wheeler, who divides the Ants into eight principal series: namely, the *Dorylinæ*,

the *Cerapachyinæ*, the *Ponerinæ*, the *Leptanilinæ*, the *Pseudomyrminæ*, the *Myrmicinæ*, the *Dolichoderinæ*, and the *Formicinæ*. Only the *Myrmicinæ* and the *Formicinæ* are cosmopolitan; all the rest are tropical or sub-tropical. The common ancestors of all would appear to be the *Ponerinæ*.

After all, these nomenclatures, which are frequently much more complicated than Wheeler's (for example, Forel's and Emery's) are of actual interest only to the technical myrmecologist.

The ants and the termites are, above all, social insects. The bees, contrary to the general belief, are social only by exception. As a matter of fact, ten thousand species of bee are known to science, of which only five hundred live in societies, whereas there is not a single species of solitary ant or termite.

Unlike the termites, which are confined to hot countries, the ants have invaded almost all the habitable portions of the globe, excepting

only the extreme north and very high altitudes. Geologically they appear to be of later origin than the termites, whose ancestors are the *Blattoidæ*, insects, as yet solitary, belonging to the Cretacean or Secondary period, and themselves the descendants of hypothetical *Protoblattoidæ*, which lived, presumably, in the Permian, the superior portion of the formation of the Primary period.

II

The ants are the most abundant of all insects in the Tertiary deposits. We find them in the Eocene, the most ancient of these deposits. There, it is true, they are somewhat rare. In the Oligocene and the Miocene, on the other hand, they are found in considerable numbers. Eleven thousand seven hundred and eleven specimens contained in the Baltic amber have been examined, as well as hundreds of other specimens found in the Sicilian amber of the middle Miocene. But here is a most disconcert-

ing fact: contrary to expectation, we find that the more ancient ants are not more primitive than those found in fossil amber, and that the latter, despite the millions of years which divide them from the ants of today, are almost as fully specialized, almost as civilized as the latter. Many of them, Wheeler tells us, had learned to seek out plant-lice, and were consequently "trophobiotic," as is demonstrated by a block of amber in the Königsberg collection, which contains workers of *Iridomyrmex Gœpperli*, together with a number of plant-lice. It can hardly be doubted that the ants of the amber had myrmecophiles in their nests, since Klebs, in his list of the coleoptera of the amber, mentions three kinds of *Paussidæ*. And the *Paussidæ*, together with the *Clavigeridæ*, are the most dangerous of parasites, for the workers of the nests in which they establish their domicile become etheromaniacs.

Now the rearing of cattle and the maintenance of parasites, and above all, of such col-

coptera as must be regarded purely as luxuries, mark, as we shall see, the culminating point of their present civilization. What, then, are we to conclude? Well, if we choose we may draw very strange conclusions: as, for example, that evolution is less proven, less certain than is generally asserted; that all the species, with their divers degrees of civilization, date from the same moment, and were, as the Bible declares, created on the same day; and consequently, that tradition is nearer to the truth than science. It may be remarked, *en passant*, that the universal discrimination of the ants and the termites, which are found in all countries of the Old World and the New alike, reminds us of another tradition, more or less esoteric, and anterior to the Bible, which claims that all civilization descended from the boreal regions, and speaks of the Antarctic bridge, as hot as the Equator, by which all the continents were joined.

But without venturing on such hazardous

conjectures, without going so far afield, we may very reasonably maintain that the ant is older, and vastly older, than the oldest geological specimens. For the earliest ants we should have to go back far beyond these specimens, hundreds and even thousands of millions of years, back into the horror of almost infinite time, back to the Precretacean, back to the close of the Permian period, which was characterized by a high temperature and extreme aridity. But before the Mesozoic, in the Secondary period, no fossils are found.

It is possible also to maintain that all evolution is thousands of times more gradual than we imagine it to be; so incredibly gradual that it will not reach its goal in time, that before reaching it—if we admit that anything can have a goal—our earth will probably have disappeared.

Nevertheless, according to some myrmecologists—notably, according to Wheeler—a highly plausible evolution is revealed, whose steps may

be followed from species to species. According to them, the ants, impelled by various circumstances, passed from terrestrial life, which was their original mode of existence, to arboreal life, and from the entomophagous régime, during which they were essentially predatory, nourishing themselves only on the flesh of other insects, to the aphidicultural or pastoral régime, and finally to the fungicultural, that is, the agricultural and vegetarian stage. This evolution—which is not, however, irrefutably established, and of which all the stages coexist today—is strangely like that of man, who has been successively a hunter, a herdsman and an agriculturalist. And we find here likewise the three stages of human history recognized by Auguste Comte: conquest, defense, and industry. These, assuredly, are curious coincidences.

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III

The population of the ant-hill or ants' nest consists of queens, or fertilized females, who

live as long as twelve years; countless numbers of workers, unsexed males or females, who, being less overworked than bees, live for three or four years; and some hundreds of males, who disappear after five or six weeks, for in the insect world the male is almost always sacrificed.

The males and females alone possess wings, which, for that matter, they discard after the nuptial flight. There is not, as among the bees and termites, one sole queen or mother, but as many fruitful females as are judged to be necessary by the secret council which presides over the destinies of the myrmecæan republic. In small nests there will be two or three, in large nests as many as fifty, and in confederate nests their number is indeterminate.

Here we are confronted once more by the great problem of the hive and the termites' nest. Who reigns and governs in the State? Where is the mind or spirit that gives the orders which are never disputed? Concerted action is as indubitable and as wonderful among the

ants as among the bees and termites, and must present greater difficulties, for the life of the ants is, in general, far more complex and adventurous, and richer in unforeseen contingencies. In the absence of a better explanation, perhaps the most admissible is that which I suggested in *The Life of the White Ant:* namely, that the formicary must be regarded as a single individual, whose cells, unlike those of our bodies, which number about sixty trillions, are not agglomerated but are dissociated, disseminated, externalized, while remaining subject, despite their seeming independence, to the same central law. It is equally possible that we shall one day discover in the ant-hill a whole complex of electro-magnetic or etheric or psychic relations of which we have as yet but the vaguest notion.

IV

As a matter of fact, if we look more closely, we shall find that our sixty trillions of cells, although they are enclosed in our bodies, are

relatively as widely disseminated as the thousands of bees, termites or ants outside the limits of their dwellings. The intervals between cell and cell are in proportion to their size, or rather, in proportion to the size of the electrons which constitute their soul; and these distances must, comparatively speaking, be as great as the distances which separate the stars in the heavens, for the infinitely little is equivalent to the infinitely great. If the human body (as Wheeler very justly remarks) could be compressed until its electrons are in contact with one another, its volume would not exceed a few cubic millimeters. This compression or density is not impossible, since nature has realized it in certain stars known as "white dwarfs," notably in the mysterious satellite of Sirius, on which a pint of water—if water could remain liquid there—would weigh nearly thirty tons.

If this be so we can more readily explain why, as we shall see later on, the workers of an enormous colony of confederate nests know, or

rather "feel," with a precision which amazes us, how many fecundated females are indispensable. When we are hungry and thirsty an analogous phenomenon occurs in our vast confederation of cells. They experience a collective hunger and thirst. All our cells experience this hunger and thirst simultaneously, and they order those which act upon the external world to do what is necessary to satisfy the general hunger and thirst, just as they command them to cease operations so soon as they are appeased.

It will be seen that this comparison is less temerarious than might have been supposed. Each of us is merely a collective being, a colony of social cells; but we do not in the least know what commands, directs, regulates and harmonizes the prodigiously complex and disseminated activities of our organic life, the basis of an existence of which our conscious or intellectual life is only an accessory manifestation, belated, precarious and ephemeral. We do not know, we cannot understand our own secret, which seems

to us so obvious; how then can we hope to fathom the great analogous secret which is concealed in the colonies of the social insects?

V

It is probable, then, that there is, to begin with, a collective and unanimous life which guides, in a massive or general fashion, the destinies of the formicary. But within this general and fundamental movement a host of individual activities are perceptible which support it, and may even exert an influence over the direction which it follows. As in our human history, we detect a certain liberty within its inevitability. In order to realize this we have only to observe the ants at work. We shall there at once behold the picture drawn by Huber, to whom we must refer the reader, for it cannot be described more precisely than he has described it:

"It is above all when the ants begin some undertaking that we seem to see an idea taking shape in their minds and being realized in exe-

cution. Thus, when one of them finds on the nest a couple of intersecting blades of grass, which might favor the formation of a cell, or a few tiny beams which outline the sides and corners of such a cell, we see the ant examine the different parts of this arrangement, and then, with great skill and consistency, place fragments of earth in the gaps and along the stems; bringing from all directions the materials which it may require, sometimes even without respecting the work which others have begun, so wholly is it dominated by the idea which it has conceived, and which it pursues without succumbing to any distraction. It comes, and goes, and returns again, until its plan has become perceptible to other ants. . . .

"In another part of the ants' nest several bits of grass seemed to have been placed expressly in order to form the framework of the roof of a large cell; a worker took advantage of this arrangement; these fragments, lying horizontally half an inch from the ground, crossed one

another in such a manner as to form an elongated parallelogram. The industrious insect began by placing earth in all the corners of this framework, and along the little beams of which it was composed; the same worker then placed several rows of these materials in juxtaposition, so that the roof of the house was beginning to grow quite distinct; when, having perceived the possibility of employing another plant as the support of a vertical wall, it laid the foundation of this wall in the same manner. Other ants having by then arrived, they completed in common the structures which the first had begun."

VI

We have all observed similar scenes, when a scrap of grass has had to be transported, or an insect dissected and carried into a gallery too narrow to admit it whole, or when it has been necessary to cross a pool of water. They recur in all critical or abnormal circumstances—at least, in all that we are able to perceive and

understand—which are, of course, few enough in comparison with those that completely escape our attention. An idea is not adopted unless it seems to be a good one. We have here no pre-established understanding, no innate agreement, but appreciation of the circumstances and decisions formed on the spot before setting to work, as in a group of men who had a general but not a detailed plan of a house which they had to build. The spectacle is even more striking when a decision has to be taken on which the future of the colony may depend; notably in the case of emigration, when the nest is abandoned; and especially in mixed nests, that is, nests inhabited by masters and slaves, or auxiliaries of two different races, whose intelligence and habits are dissimilar. The *Glebariæ*, for example, who are the housekeepers of the Amazons, find that their house is becoming inadequate; for they are more acutely aware of all its inconveniences than their owners, whom they tend and feed, and who emerge from their

apathy only to go to war. One of these masterful servants, in her incessant explorations, discovers, in the neighborhood, a spacious deserted ants' nest, which she considers to be more comfortable or more advantageously situated than her own. By taps of her antennæ she informs two or three of her sisters of her discovery, drags them almost by force to the more desirable nest, and demonstrates its advantages. They allow themselves to be convinced, and recruit proselytes in their turn, and presently, by a minority, reënforced by the attraction of novelty, the emigration is decreed. The next thing to do is to remove the warriors. Are they consulted? It is hardly probable. In any case, each slave takes charge of one of her mistresses, carries her to her new home, and deposits her on the threshold, where she is received by other slaves, who show her the way intc the cellars; after which they busy themselves with transferring the eggs, larvæ and nymphs.

Sometimes there is a dispute, and a portion of

the colony refuses to join in the migration; sometimes the emigrants regret leaving their old nest and return to it in a body.

These facts are by no means imaginary or unduly humanized. They have been observed repeatedly, and anyone may verify them who will take the trouble to do so. They show that the part played by the mysterious agreement or innate understanding may be restricted. This understanding is manifested more particularly in the distribution of work, in the estimation of the number of males and females indispensable to prosperity, and in certain other important conjunctures. But is it spontaneous and purely instinctive? Let us confess that we do not know. We have not been present at the deliberations of the workers, and we know hardly anything of what happens in the depths of the formicary. To interpret is not always to understand. At most we are able to state that the ant seems often to hover, like ourselves, between instinct, which represents destiny, and in-

telligence, which may deflect the straight line of destiny. But so soon as intelligence makes its appearance in this world it evokes dangers and gives rise to difficulties which are unknown to instinct. On the other hand, it averts other dangers and difficulties which instinct could not have avoided. The ant has entered upon the path which we ourselves are following, and this is why it is acquainted with human errors and perils. It is borne onward, like ourselves, by an unknown fate, but like ourselves it is free to move within its restricted sphere. Have the internal activities modified the path of this sphere? Before we could answer this question—or most other questions, for that matter—we should have to know more than it is possible for us to know.

VII

What name shall we give this kind of understanding, and to the government which results from it? Which of our human formulæ would be even approximately applicable here? Is it a

mere republic of reflexes? But could such a republic lead to anything save death? Is it, as it has recently been called, an "organized anarchy," or a "cumulative collectivity"? Theocracy and monarchy may be rejected as improbable; and what is left? Democracy; oligarchy, and—what seems more probably—aristocracy and gerontocracy. We shall always find that the ants, when at work, follow the example of a few workers who have more initiative than their fellows. There is nothing to distinguish these workers from the crowd: they wear no distinctive badge or uniform; but there is no doubt that their companions recognize them, and willingly give heed to them. Are they veterans, full of experience, or young chieftains full of genius? Their orders are counsels rather, and often enough they have to explain their reasons, and the advantages to be gained: governing less by authority than by persuasion. Here, one might say, is the provisional government of the best ideas, based on the solid and stable founda-

tion of the general instinct. We must not lose sight of the fact that in the world of the ants all things are done beneath the supreme sign of unity and love—but a virgin, disinterested love, of which we shall never have any conception—which enormously increases and extends its empire.

It was of this that Huber had a presentiment. "Thus," he tells us, "the great secret of the harmony which we admire in their republics is by no means so complex a mechanism as is generally supposed: we must look for it rather in their reciprocal affection." And this reciprocal affection, as we shall presently see, derives directly from an absolutely special organ, whose functioning controls the entire psychology and morality of the ants' nest.

To Huber's remark Espinas very justly adds the comment: "I would say rather that we must look for this secret in their common affection for their larvæ, and (for besides the end one must indicate the means) to the small dose of

individual intelligence with which the hymenoptera are endowed, multiplied by the laws of imitation and accumulation which we have indicated."

We may indeed verify the fact that contrary to what may be observed in human crowds, the collective and cumulative intelligence of the social insects seems to be in proportion to the number of cells which compose the organism, for the more populous species and agglomerations are in general the more enterprising, ingenious, and civilized.

However this may be, it seems to me that Huber's "reciprocal affection" and Espinas' "common affection for their larvæ" are very near the truth. We have here the ideal republic which we shall never know, the republic of mothers. Though virgin, all its citizens feel themselves to be mothers by delegation, more profoundly and passionately than the actual progenetrix. Seek where you will in nature, you will nowhere find so magnificent a maternal

love. The hen defends her chickens against whatever enemy, but she does not love her eggs. Cut off the abdomen of a worker ant who is trying to save a cocoon, cut off her two hind legs, if you have the odious courage; and without releasing her hold, walking on her four remaining legs, and dragging her entrails behind her—for her vitality is as prodigious as her love—she will pursue her path, and will refuse to die until the nymph or larva, which for her represents the future, is safely bestowed.

In this heroic matriarchate each worker obstinately does her duty to the profit of all, as though all were but herself. The center of gravity of conscience and happiness is not where it is with us. It is not in the individual, but wherever there is a cell of that whole of which the individual forms a part. The result is a government superior to any that man will ever be able to realize.

THE SECRET OF THE FORMICARY

THE SECRET OF THE FORMICARY

I

FROM the days of Æsop, whose sources were prehistoric, to those of La Fontaine, the ant was the most calumniated of insects. Contrasted with the cigale, which was, for some unknown reason, endowed with all the facile and decorative virtues, she became the crabbed symbol of suspicious parsimony, of envious meanness, of narrow, malevolent, petty churlishness. As compared with the great and misunderstood artist, she represented the petty bourgeois, the small investor, the subordinate official, the small tradesman of the back streets of a little town without proper sanitation; and the very people who resembled her most closely despised her most profoundly. To rehabilitate her and to do her justice the labors of the great myrmecologists were necessary; and of these

the earliest, as we have seen, was Pierre Huber.

Today it is accepted as proven that the ant is incontestably one of the noblest, most courageous, most charitable, most devoted, most generous and most altruistic creatures on earth. As far as that goes, she can take no credit for this, any more than we can take credit for the fact that we are the most intelligent of the creatures inhabiting our planet. We owe this advantage merely to a monstrously developed organ with which nature has endowed us, just as the ant owes the virtues which have been enumerated to an organ of another kind with which she has been endowed in an exceptional degree, as the result of a caprice, an experiment, or a fantastic idea by the same nature.

The ant, in fact, possesses at the entrance of the abdomen an extraordinary pouch, which might be called the social pouch or crop. This pouch explains her entire psychology and morality, and the greater part of her life's career;

and for this reason we must examine it carefully before proceeding farther. This pouch is not a stomach; it contains no digestive glands, and the food which is accumulated therein is preserved intact. Since the alimentation of the ant —who has powerful mandibles for seizing her prey or her enemy, for piercing, cutting, dividing, decapitating and tearing, but has no teeth which can masticate—is almost entirely liquid, a sort of saccharine dew, the sac in question being a collective flagon, reserved exclusively for the community. This flagon or leather bottle is ingeniously and completely separated from the individual stomach, which the aliments contained in it do not reach until several days have elapsed, and after the common hunger has been satisfied. It is enormously elastic, occupying four-fifths of the abdomen, and thrusting aside all the other organs; and it can be dilated to such an extent that in certain American species —notably in *Myrmecocystus Hortus-Deorum* of the United States and Mexico—it assumes

the form of a demijohn, a jar, or rather a bonbon, eight or ten times as voluminous as the normal stomach. These insect bonbons have one sole function: they are the living reservoirs of the community. Voluntary prisoners, who never again see the light of day, they grip the ceiling of the nest with their forefeet, hanging from it in serried ranks, giving it the appearance of a well-ordered cellar, into which the honey-dew gathered outside is disgorged, and to which the inhabitants resort in order to demand its regurgitation.

Pardon the word: it is inevitable. It reminds one of indigestion and its unpleasant concomitants; but, like the rumination of cattle, it has nothing in common with these. It is the technical term, beloved of the myrmecologists, who are forced to abuse it a little; but it must be admitted, for regurgitation or disgorgement is the essential and fundamental act whence the social life, the virtues, the morality and the politics of the formicary are derived; just as that which

distinguishes us from all the other inhabitants of this earth is derived from our brain.

II

"The ant," says the fable, "does not lend." That is true; she does not lend, for to lend is but the gesture of the miser; she gives without reckoning, and she never asks for repayment. She possesses nothing, not even the contents of her own body. She hardly thinks of eating. What does she live on? It is difficult to say: on the atmosphere, on diffused electricity, on vapors or effluvia. Starve her for weeks on the plaster of an artificial ants' nest, and so long as you provide a little moisture she will not suffer in any way; she will busy herself about her petty affairs, as alert and active as if her cellars were full to overflowing. A drop of dew will fill her individual stomach. All that she is constantly seeking and amassing is intended only for the collective crop, the insatiable communal sac; for the eggs, the larvæ, the nymphs, her

comrades and even her enemies. She is nothing but an organ of charity. An indefatigable worker, ascetic, chaste, virgin, neuter—that is to say, sexless—her sole pleasure is to offer, to whomsoever will partake of it, the whole fruit of her labors. For her regurgitation must be an act as delightful as is for us the degustation of the choicest meats and wines. It seems evident that in this act, nature has incorporated pleasures analogous to those of the love of which she is deprived. The ant, regurgitating with reverted antennæ, has an ecstatic appearance (as Auguste Forel has remarked), and evidently experiences a greater pleasure than the comrade who is gorging herself with honey. And in most formicaries regurgitation is, so to speak, incessant, and is interrupted only by labor, the care of offspring, rest, and war.

It may even be questioned whether the ant, whose social crop is dilated to bursting, is able to pass a single drop into her individual stomach.

We know that certain warlike races, and notably *Polyergus rufescens*, which Huber calls the Amazon, are unable to feed without the help of regurgitating slaves, and would die of hunger in a pool of syrup. This species of perpetual communion of mouth to mouth is thus the normal and almost general form of alimentation.

To convince oneself of the fact, it is enough to tinge a few drops of honey with some blue dye, and offer them to one of our little yellow ants, whose bodies are almost transparent. We shall soon see her stomach dilating and assuming an azure tinge. Burdened with honey, she returns to her nest. Half a dozen mendicant comrades, attracted by the odor of honey, feverishly stroke her antennæ. She satisfies them immediately, and the stomachs of all those about her become blue. They have hardly finished feasting when they are solicited by other comrades, coming up from their underground galleries, who in turn partake of the revealing

drop, and so on, until all is consumed. After this the first benefactress, who has given all that she possessed, trots cheerfully away, evidently happier than if she had just enjoyed three or four sumptuous meals.

III

The mendicant need not even be a fellow-citizen; any stranger, provided she is more or less impregnated with the odor of the nest, any daughter of a race which is not too obviously fundamentally hostile, if the doorkeepers have permitted her to enter the nest, or a parasite even, which may be harmful but is for some inexplicable reason tolerated by the general benevolence, provided the supplicant understands how to set about the business, how to caress the benefactor, may obtain all the food desired. Nothing is more easily deceived than the ant's imprudent charity. We shall even see ants which in the thick of the mêlée cannot resist the solicitations of a hungry enemy; they

will give it alms, and chivalrously revictual it before resuming the struggle.

Sometimes their charity goes too far, and leads to the ruin of the colony. For example, a Tunisian ant, the *Wheeleriella*, which has been studied by Dr. Santschi, introduces herself into the nest of another species, the *Monomorium Salomonis*. She is at first rather coldly received, but presently, by means of skillful caresses, she gains the favor of the workers, who end by preferring her to their own queens, whom they abandon and ill-treat for the benefit of the astute adventuress, whose charms appear to be irresistible. Shortly after this the usurper begins to lay her eggs. Her species, which is essentially parasitic, and never works, is the only one to proliferate, and substitutes itself for the too hospitable and too confident workers, whose race dies out. Misery, famine and death follow; and the parasites disappear in their turn, the victims of a victory too complete. Have we here simply an action purely and inexplicably im-

becile, peculiar to the world of insects? Have we not in our world analogous and equally inexplicable aberrations? Is it not rather a curious and significant example of instinct, infallible in principle, which in over-civilized races, as in man, makes fatal mistakes, because intelligence, sentiment or intrigue intervene? We shall return to this problem later.

IV

But is not our interpretation of all the foregoing actions too human? Is it not possible that the caress of the antennæ provokes a mere reflex, analogous to the erotic reflex, involuntary and irresistible? It may be so; but if we were to interpret the majority of our own actions in the same fashion we should come to the same conclusions. Do not let us go too far in our dread of anthropomorphism; for if we do, all will become purely mechanical and chemical, and there will be no room for life properly so called; and life is always unexpectedly giving

the lie to the most confident determinism. Notably, in more than one instance the ant solicited repulses the caress, deliberately and obviously, expelling and maltreating the intrusive suppliant. Do not let us too hastily declare that there is nothing here but incoherence, stupidity and automatism. If we were to argue on these lines, what would remain of the majority of our own actions, and of our virtues? Whatever their interpretation, the facts recorded are exact, and are confirmed by all those myrmecologists who have studied them, and for that matter, anyone who desires to do so may verify them, since the study of the ants, which are abundant everywhere, on the surface of the soil and even in our houses, is very much easier than that of the termites.

V

For the moment, it is interesting to note that the three insects whose civilization is vastly superior to that of all others possess a social or

collective organ, which, if not identical, performs analogous functions. Thus, it is by regurgitation—stomachal in this case—that the bees nourish their nymphs and their queens. For that matter, all the honey of the hive is merely a regurgitated nectar. In the termites the altruistic organ is sometimes the stomach, and more often the abdomen. Is there some relation between the more or less complete altruism of this organ and the degree of civilization attained by the three insects? I do not know, but if I had to compare them I should place the ant in the first rank, and then the termite, and lastly, despite the prestige of its vivid life, its marvelous skill, its wax, and its honey, our domestic bee.

Let us suppose for a moment that we possessed a more or less analogous organ. What would humanity be had it no other care, no other ideal, no other aim in life than selfless giving and the happiness of others; if to work solely for one's neighbor, to sacrifice oneself

permanently and wholly, were the only possible joy, the essential felicity; in a word, the supreme bliss, of which we perceive only a fugitive gleam in the arms of love?

Unhappily we are so made that the very contrary of this is true. Man is the only social animal to possess no social organ. Is this the reason why his socialism and communism are precarious and artificial? It is impossible for us to live otherwise than centripetally, whereas the ants are naturally centrifugal. The pivots of our lives turn in contrary directions. With us all is necessarily, organically, inevitably egoistic. By giving we exceed the law of our being; we betray ourselves, by an effort which makes us emerge from our proper state, and which we call an act of virtue. In the ant all is otherwise: it is in sacrificing herself, in lavishing herself that she follows her natural bent; it is in refusal that she conquers herself and transgresses her instinctive altruism. The poles of the two moralities are inverted.

We too possess an altruistic organ, but on a different plane. This organ is in our mind, and sometimes in our heart; but since it is not physical it is without efficacy. Will the function, will the moral spiritual urge end, as the transformists believe, by creating the material organ? It is not impossible. Nature, with the complicity of the centuries or the millenia, may be capable of miracles for which we dare hardly hope. Nevertheless, it must be confessed that today the miracle seems less imminent than of old; that many periods have been more generous than our own. The religions were, so to speak, the rough sketch, the rudiments of an altruistic and collective organ, which promised, in another world, the joys which the ant experiences by giving herself in this world. We are now in the act of extirpating them, and nothing is left us but the egoistic and individual organ of the mind, which may one day surpass itself and shatter the circle that confines it; but God alone knows when.

We must not, however, forget that even in the ants this universal charity, this perpetual communion, does not prevent wars: though the wars of the ants are less frequent and less cruel than is generally believed.

THE FOUNDING OF THE COMMUNITY

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I

GOVERNMENT and order, in the formicary, are better balanced and more stable than in the hive, which is subject, every year, and often more than once in the year, to dynastic or matrimonial troubles which imperil its prosperity and its future. In the termitary, on the other hand, the celebration of nuptials, in which the males perish by thousands, is extremely onerous to the community, and often opens the gates of the city to the enemy.

In the world of the ants the nuptial flights, in which the males encounter the females and fertilize them once for all, are accompanied by less ostentation, and are more economical. As befits the humble livery of the insects, they re-

call a modest country wedding. Nevertheless, as they are very often held on the same day, in order to favor cross-fertilization, by all the formicaries of the district, they give rise to a certain effervescence in the atmosphere, and above all on the surface of the ants' nests. There the workers, uneasy and excited, lead from the nest those females who are about to fulfill their perilous duty, accompanying them as far as they can, as though to encourage them or bid them farewell; for they will never see them again. For the ants, as for the termites, love almost always wears the face of death. Not one of the males will survive, and of a thousand virgins who soar heavenwards only two or three at most will fulfill their destiny, and know the miseries which we shall presently describe.

For the rest, a provident and well-organized police watches the entrances of the nest, and its immediate surroundings, and this police does not permit all the females to take the flight from which none returns. The community must

not be wholly deprived of young mothers and robbed of its future. The warders retain by force such females as they find on the dome of the colony, clinging to their legs, tearing off their wings, and leading them back to the depths of the nest, where they will remain as prisoners to the end of their lives. But how are they chosen? Who counts them and proportions their number to the importance and the needs of the republic? We do not know.

II

I shall not attempt to improve on Réaumur's description of these humble nuptial dramas, which he was the first to record. Here is the picture which he gave of his discovery: which, by the way, attracted no attention, since it remained buried in a manuscript which has but recently been published in America.

"While traveling to Poitou I found myself on the embankment of the Loire, not far from Tours, on a day early in the month of Septem-

ber, 1731. I alighted from my coach, being tempted to walk by the beauty of the neighborhood, and by a temperate breeze, most agreeable after the heat which had persisted during the earlier part of the day. The sun was within an hour of reaching the horizon. In the course of my walk I saw a great number of little heaps of sandy and earthy particles, raised above the orifices which led the ants to their underground dwellings. Many of these ants were at that time outside their nests; they were red, or rather rust-colored, and of middling size. I stopped to examine several of these little mounds of earth, and I noted on each of them, amidst the wingless ants, some winged ants of two very different sizes; some were no larger in body than the wingless ants, while to judge merely from the look of them one of the others must have weighed as much as two or three of the latter. On this beautiful embankment, where I found it so pleasant to walk, there appeared in the air, at inconsiderable intervals, little

clouds of large midges, flying very quickly, and eddying round and round, and which one might have guessed to be gnats, or crane-flies, or some kind of papillonaceous midge. Often the little cloud remained in the air at such a height that a hand could reach it. With one of my own I caught some of these flies, and I did this on a number of different occasions. All the insects which I thus captured were readily recognized for what they were: they were winged ants, like those which I had found at every step on the little mounds of earth. But a point which was as easily remarked as it was essential was that I almost always caught them in pairs. Not only did I almost always find a large ant and a small one in my hand, but I most frequently found them joined together, and I held them for some time without their separating. The small ant was lying on the large one, just as in the pairing of common flies the male lies on the female. The posterior of the small ant was recurved in order to press against that of the

female, and it adhered to the latter so firmly that it was necessary to employ force in order to separate them. The body of the little male was barely half the length of that of the female, so that it was able to cover only the posterior portion of the female's body. I squeezed the bodies of several of the large ants, and this caused clusters of eggs to emerge from them."

III

Each female has five or six mates, whom she often carries off with her in her flight, and who wait their turn; after which, falling to the ground, they perish in a few hours' time. The fertilized female alights, seeks shelter in the grass, discards her four wings, which fall at her feet like a wedding-gown at the close of the feast, brushes her corselet, and proceeds to excavate the soil, in order to cloister herself in an underground chamber, and there attempt to found a new colony.

The foundation of this colony, which fre-

quently ends in disaster, is one of the most pathetic and heroic episodes of insect life.

The ant who will perhaps be the mother of an innumerable population buries herself in the ground and there makes for herself a narrow prison. She has no other food than that which she carries in her body, that is, in the social crop—a little store of honey-dew—her tissues, and her muscles, and above all the powerful muscles of her sacrificed wings, which will be entirely reabsorbed. Nothing enters her tomb save a little moisture, pluvial in origin, and, it may be, certain mysterious effluvia of which we do not as yet know the nature. Patiently she awaits the accomplishment of her secret task. At last a few eggs are spread about her. Presently a larva emerges from one of these eggs; it spins its cocoon; other eggs are added to the first; two or three larvæ emerge. Who feeds them? It can only be the mother, since the cell is impervious to everything but a little moisture. Now she has been buried for five or six months;

she can do no more, for she is nothing but a skeleton. Then the horrible tragedy begins. On the point of death—a death which would at one blow destroy the future which she has been preparing—she resolves to eat one or two of her eggs, which will give her strength to lay three or four more, or she resigns herself to devouring one of the larvæ, which will enable her, thanks to the imponderable aliments whose nature is unknown to us, to rear and nourish two more; and so, from infanticide to parturition, from parturition to infanticide, taking three steps forward and falling two back, yet steadily gaining on death, the funereal drama unfolds itself for close upon a year, until two or three little workers emerge, weakly, because ill-nourished from the egg, who pierce the walls of the *In Pace,* or rather the *In Dolore,* and seek, in the outer world, their first victuals, which they carry to their mother. From this moment she has no more cares, no more troubles, but night and day, until her death, does nothing but lay

her eggs. The heroic days are gone; abundance and prosperity replace the long famine; the prison expands and becomes a city, which spreads underground year after year; and nature, having here played out one of her cruelest and most inexplicable games, goes further afield, and repeats the same experiments, whose morality and utility are as yet beyond our understanding.

This mode of genesis suggests an observation regarding heredity and innate ideas which is not without interest. Here is a female, who before the nuptial flight had never ventured into the outer world, and had never taken part in the labors of the formicary. From one day to the next she is immured in her impenetrable tomb, and there she knows all the trades of her species without ever having learned them. She digs the soil, excavates cells, feeds her larvæ, opens the cocoons of her nymphs; in short, though equipped with tools far less perfect than those of the workers, she succeeds in doing all

that they do. Does it not seem, as I have already suggested, that the diffused and collective soul of the community decrees that each of its constituent cells shall manifest it completely, even when separated from it, and continue the life of the community in time and space as though it were the life of a single being, which knows all things, and will die only when the earth itself shall die?

IV

We have just been considering the proper and normal birth of a colony. As usual, Huber was the first to study and describe the process. His observations were completed by Lubbock, McCook and Blechmann (for the red ants and the tropical *Camponotus*), Janet (for *Lasius*), Pieron (for the *Messeres*), Forel (for *Camponotus ligniperdus*), Simpel (for *Lasius flavus*), etc. Anyone may repeat and control these experiments. It is enough if one summer night, when they are swarming everywhere, even en-

tering our houses, we collect a few females, which are easily recognized, being very much larger than the males, and cloister them in a box full of earth, which must be kept moderately moist. I must warn you, however, that a good many of such experiments will be wasted; in the first place, because it often happens that the female is a virgin; and still more often because the experimenter is not sufficiently patient and careful.

I need hardly add that owing to the extraordinary physical and moral polymorphism of our heroines, and their prodigious powers of adapting themselves to the most unusual circumstances, a community may be founded in many different ways. The *Raptiformica*, for example, and their kindred, found their communities by simply expelling from its nest a tribe of *Serviformica fusca*. In some cases ants of two or three different races unite and pool their resources; others have recourse to adoption, to alliance, forced or voluntary, or to shameless

or clandestine parasitism. A somewhat ingenious parasitism is that practiced by *Harpagonexus subleirs*, which has ergatogyne females—that is, females who resemble workers. These ergatogynes, heavily armored with invulnerable chitine, force their way into the nest of a pacific species and drive out the inhabitants, whose larvæ and nymphs they rear, in order that they may act as nurses to their as yet unborn young.

One fertilized female, the *Carebara vidua*, belonging to a celebrated South African race, has solved the critical problem in a very neat manner. This queen, far from resembling her workers, exceeds them *three or four thousand times in volume*. Equipped with magnificent wings, she is like the Victory of Samothrace, as we see her in the Louvre, beside a host of ivory statuettes. It is inconceivable that offspring so dissimilar should issue from almost similar eggs. Here we have the mystery of a polymorphism which seems to be chiefly due, like that of the bee, to the alimentary régime.

However this may be, she could no more rear her Lilliputian children than an ostrich could hatch and rear a breed of humming-birds. For this reason, on her nuptial flight she carries, clinging to the hairs of her legs, a dozen blind workers, who will undertake all the necessary domestic tasks, and tend the eggs, larvæ and nymphs. Who selects them, and what decides them to risk the tragic adventure? Once more, we find ourselves in a world of mystery and monstrosity exceeding that of our most extravagant nightmares. But while noting these fantastic anomalies, these disconcerting errors, these bewildering insanities of nature, must we not marvel at the ingenuity with which their victims strive to redeem them?

V

Since I have spoken of eggs, larvæ and nymphs, let me briefly elucidate the subject.

If on a fine summer day we remove the top of an ant-hill, we see, under the sand or pine-

needles, a multitude of tiny objects like grains of wheat or rice, which are commonly taken to be eggs. They are nothing of the kind. The eggs, which are very minute, almost always escape our notice. What we now see—this moving heap of grain, which immediately swarms with excited workers—consists of the larvæ which emerge from the almost invisible eggs. They are not unlike Egyptian mummies in their coffins of sycamore, with gilded masks; or like prematurely old, sardonically frowning children, as though nature had hesitated between the homunculus and the insect; carefully hooded and swathed in swaddling-bands, and provided with pendent teats. They are sometimes naked, and merely, so to speak, withdrawn into themselves, and sometimes enveloped in a cocoon, within which the metamorphosis into the nymph is accomplished; and the nymph, in turn, either remains naked or weaves itself a cocoon, from which, by its own efforts or with the assistance of the workers,

the perfect insect emerges, male, female, or neuter, according to the decision made—by whom we knew not—when it was still in the egg or in the larval state. Merely in respect of longevity the fate of these three insects is very different. The males all perish after the nuptial flight. The workers, exposed to the countless perils of the outer world, and worn out by their labors, rarely live longer than five or six years; whereas it has been demonstrated that in artificial ants' nests, the only kind of nests which it is possible to observe seriously and continuously, a fertilized female may live more than fifteen years. But the problem of predestination, which in the bee is conditioned by the cell and the diet of the larva, and in the termite by the diet alone, is not as yet definitively solved in the case of the ant.

Who controls this predestination—who foresees or calculates how many workers, fertilized females and males are essential to prosperity? Who calculates the ratios of these numbers, de-

termines them, and establishes a mutual harmony between them? As to this, we know nothing; just as we do not know, and it may be shall never know, what guides the stars and controls their movements in the heavens; for the mystery, whether it resides in the infinitely great or in the infinitesimally small, is precisely the same mystery.

One final problem remains: how, in the populous colonies which endure sometimes for half a century, and contain as many as two or three millions of inhabitants, are the fertilized females recruited? These "polycalic" colonies or confederate nests need a certain number of prolific females to maintain their population.

Each species solves the difficulty in its own fashion. Sometimes, after the nuptial flight, instead of founding a community, the female returns to her native nest. She is received with more or less eagerness, according to the demands and computations of the collective instinct. Sometimes the workers assemble, before

the entrances of the nest, as many fertilized females as they judge to be necessary to the future of the colony, deprive them of their wings, and force them to reënter their home. Sometimes they go forth in search of a stranger, of their own race or of some assimilable family, or they adopt a traveler who may chance to present herself; at other times, and indeed rather frequently, the union of brother and sister, or adelphogamy, as the entomologists call it, is accomplished in the nest itself; for our humble heroines find it easier than we do to modify, in case of need, their fundamental laws, or even to reverse them, adapting themselves to circumstances, and turning them to account.

THE NEST

THE NEST

I

THE ants' dwelling has not the amber-hued and perfumed splendor of the palace of the bees, nor yet the formidable vastness and granitic solidity of the citadel of the termites. In order to compare these three orders of architecture, and to appreciate the happenings in these strange dwellings, we should have to enlarge them to our human scale. We should then perceive that in the hive a bewildering geometry prevails, sumptuous, decorative, and innumerous, which would seem to us infinitely more selenitic than terrestrial. In the termitary we should see the monstrous triumph of reënforced concrete and the perpendicular style, exemplified in a mountain of stone two thousand feet in height and perforated like a sponge. Lastly, in the ants' nest we should find the hori-

zontal style predominant, with innumerable and apparently aimless meanderings, an endless extent of catacomb cities, from which none of us, were they built upon our scale, would ever emerge alive.

The architecture of the ants is as various as their bodies and their habits. One might even say that there are as many kinds of formicaries as there are species of ant; but all may be referred to four or five principal types.

Nine times out of ten the nest is subterranean, hollowed out in the sand or loamy earth, which is pierced by galleries with countless ramifications. It often contains as many as twenty stories in its upper portion, and at least as many beneath the surface of the soil. Each story has its own purpose, which is determined mainly by the temperature, the warmer portions of the nest being reserved for rearing the young. But I need not linger over these details, which are familiar to everyone, since everyone has at one time or another opened or overturned an ant-

hill. The entrance is sometimes carefully concealed, and sometimes frankly obvious and even ostentatious, in the form of a crater, or surmounted by a dome, which is commonly the principal portion of the ant-hill, as in the mounds of pine-needles or other vegetable débris built, in particular, by our red ants, our *Pratenses* and *Sanguineæ*. Certain incubating domes (which may be compared to our own artificial incubators), of the *Formica rufa*, so common in our pinewoods, attain a height of six feet, and are as much as thirty feet in diameter at the base. It may be noted, by the way, that the temperature in the interior of these domes is always ten degrees higher (Centigrade) than that of the outer atmosphere.

The distribution of the galleries, granaries, store houses, communal halls and rearing-chambers—to which we must add, in the case of certain species, mushroom nurseries, stables, and cellars—is extremely variable, and even in two

neighboring colonies of the same race, and of equal importance, it only approximately follows a general plan, which is constantly modified in accordance with the circumstances. Thus, in one nest of *Lasius* you will find all the eggs carefully arranged near the summit; then, in a second chamber, the larvæ, classed in order of their size; and then, below these, in a third chamber, the cocoons; whereas in another nest of the same ant everything is higgledy-piggledy, and apparently left to chance; which proves once more that the collective instinct of the ant-hill, like the collective instinct of the cells of our body, which in us determines the health or sickness of the body, is in certain respects almost as variable as the individual intelligence, which it often resembles in a very singular degree.

It should be noted, in passing, that the familiar *Formica lasius* orientates the domes in which her eggs are matured and her nymphs are formed in such a way as to capture as much heat

as possible, and suppresses it entirely, because unnecessary, in sub-tropical countries.

II

Subterranean nests are generally from twelve to sixteen inches in depth, but sometimes, and notably in the case of the harvesting ants, they descend to a depth of five feet or more in the sand which contains their granaries, while on the surface there is a group of seven or eight intercommunicating craters, so that the whole of the nests form a single colony, which covers an area of fifty to a hundred square yards or more. But we shall return later on to these harvesting ants, and also to the fungus-eating ants, the weaving ants, and the pastoral species.

As for the definitely polycalic or confederated colonies, such as the colony of *Formica exsecta* which Forel found in the Jura, they often contain as many as two hundred nests, each of which may contain from five thousand to five hundred thousand inhabitants, and they

may occupy a circular area whose radius is two hundred yards or more. Dr. McCook, a distinguished and highly conscientious observer, tells us of an enormous city of *Formica exsectoïdes* in Pennsylvania which covered an area of fifty acres, and consisted of sixteen hundred nests, many of which measured nearly three feet in height and twelve feet in circumference at the base. Comparing its volume with the dimensions of the insect, McCook calculated that it was relatively eighty-four times the size of the Great Pyramid. That is to say that London and New York, compared with these huge agglomerations enlarged to our human scale, would be no more than villages. But the organization of these great colonies is not as yet fully understood.

III

In these dark dwellings—for the ant, like the bee and the termite, is a lover of darkness—the whole life of the queens is passed, and a great part of the workers' life. The days and nights

alike—for during the summer, at all events, the ants are never idle—are devoted to "the tedious and compliant labors' of the household—cleaning the nest and preparing food, since the vegetables, grains, fruits and game brought in have to be transformed into mincemeat, or paste, or broth. Then there are the continual regurgitations, an inexhaustible source of mutual delight; the upkeep of the public ways within and without the nest; the highly exacting care of the mothers, who have to be escorted, guided, guarded assiduously, plentifully fed, washed, brushed, and caressed; attentions of every kind lavished on the eggs, which have to be constantly and diligently licked, in order to nourish them by endosmosis, and on the larvæ and nymphs, which have to be turned and re-turned, and moved from place to place, and exposed, at the proper hours, in favorable positions. Then there is the personal toilet, since the ant has a perfect mania for cleanliness, and with the assistance of her companions she combs and

rubs and polishes herself twenty times a day. Lastly, there are games, friendly contests, duals and conflicts of a sportive and harmless nature. These were first reported by Huber, whose observations were at first treated as imaginary, but they have since been confirmed by Forel, Stumper and Stäger.

In order that you may once again listen to the quiet, rich and venerable voice of the father of myrmecology, I will give myself the pleasure of quoting the page which Huber has devoted to this subject:

"One day I approached some of their ant-hills, which were exposed to the sun, and sheltered from the north. The ants were assembled together in great numbers, and seemed to be enjoying the temperature which prevailed on the surface of their nests. None were working; and this multitude of assembled insects presented the appearance of a liquid in ebullition, on which the eyes had at first some difficulty in getting a purchase. But when I applied myself

to following each ant separately, I saw them approach one another, waving their antennæ with astonishing rapidity: with their fore feet they lightly stroked the sides of the heads of other ants; and after these preliminary gestures, which were like caresses, they reared up on their hind legs, two by two, and wrestled with one another, seizing a mandible, a leg, or antenna, and relinquishing it immediately, to return to the attack; clinging to one another's corselet or abdomen, embracing one another, overturning one another, falling and scrambling up again, and revenging themselves for their defeat without appearing to inflict any injury: they did not eject their venom, as they do in their battles, and they did not grip their adversaries with the tenacity to be observed in their serious quarrels; they soon released the ants which they had seized, and tried to catch others; I saw some which were so ardent in their exercises that they pursued several workers in succession, and wrestled with them for a few

moments, and the duel was concluded only when the less lively ant, having overthrown her antagonist, succeeded in escaping, hiding herself in some gallery. I often returned to this ant-hill, which almost always offered me the same spectacle; sometimes this mood was general; on every hand there were groups of ants struggling together, and I never saw any of them emerge from the combat wounded or mutilated."

IV

And lastly, incredible though it may seem, there is rest. We are really inclined to believe that the ant, whose activity seems to us so frantic, for she is flitting about, by day and by night, like a spark in a truss of hay, must necessarily be totally ignorant of fatigue. Nevertheless, she is subject to the great law of terrestrial life; she finds it necessary sometimes to withdraw into herself, to recuperate her energies, and forget life. When, after a long adventure, burdened with booty three or four

times her own weight, she returns to the nest, her companions who guard the entries hasten to meet her, and first of all demanding the regurgitation with which every notable event begins and ends in the formic world, they then cleanse her of the dust that covers her, brushing and caressing her, and lead her to a sort of sleeping-chamber, far from the tumult of the crowd, which is reserved for exhausted travelers. Then she soon sinks into a slumber so profound that even an attack upon the nest, which rouses all the inmates, down to the very invalids, will only half awaken her, and then, instead of fighting, she will seek only to escape.

V

From the citizens of the subsoil let us pass on to the arboreal ants. Some of them live in the interior of trees which they bore and excavate and hollow out as do the termites, taking care to leave the bark intact. They carve out their dwellings in the wood, superimposing a

number of stories, "whose ceilings" as Huber says, "as thin as a playing-card, are supported now by vertical partitions, which form an infinite number of chambers, and now by a multitude of small, rather slender pillars, between which one can see almost the whole depth of the story; all in black, smoky-looking wood."

If we extricate one of these nests we get the impression that we are handling some unfamiliar and complex work of art, full of minutely-wrought detail, uncouth and bewildering, like nothing else on earth, but approximately resembling certain prehistoric bones, which thousands of centuries have carved and honeycombed.

The maker of these nests, *Lasius fuliginosus*, so called because the wood which has been worked by it has the color of smoke, sometimes forms enormous confederate colonies, whose innumerable population may occupy eight or ten tree-trunks, though it seems to be obedient to the same laws, the same central impulses.

Other ants, inhabitants of the tropics, affix their nests, which are often of enormous size, in the crotch of large boughs, where these bulky excrescences approximate in color the bark of the tree. They are built of a sort of paper, like that which is made by our wasps.

Then there are ants which make their nests either in natural cavities adapted to the insects' requirements, or in the hollow stems of certain plants, which sometimes provide small colonies with both food and shelter, as happens in the world of fairy-tales; and there are ants with nomadic nests, who live, so to speak, in tents, contenting themselves, on their incessant expeditions, with any provisional shelter that offers in which they can shelter their larvæ and nymphs for the night. Lastly, we must not forget the nests woven by the weaving ants, which in the world of ants, and perhaps in the animal world as a whole, occupy the summit of the intellectual hierarchy. But of these we shall speak at greater length in the chapter

which will be devoted to them, for they are deserving of more than mere mention.

VI

It goes without saying that in the case of all these dark and jealously sealed nests it is almost impossible to make effective observation. For this reason the myrmecologists have devised—as the apiculturalists did before them—various kinds of apparatus which enable them to follow, from hour to hour, and without perceptibly disturbing it, the normal life of the ants which they wish to study. Swammerdam, in his *Biblia Naturæ*, published in 1737, described the first artificial nest of which we have any mention. He simply placed the captured ants in a plate containing some friable soil, surrounded by a trench of wax filled with water.

Huber, who could not have known of Réaumur's "pounce-boxes," since Réaumur wrote fifty years later, prepared a small table, the top of which was provided with a longitudinal slit,

and fixed beneath it a glass box, enclosed in wooden shutters—for the ants, like the bees, work only in darkness—and covered the whole with a glass bell-shade, so that the insects were able to build the upper stories of their nest on the surface of the table.

Since then better devices have been invented. Forel, Lubbock, Wasmann, Adèle Field, Charles Janet, Wheeler, Santschi, Brun, Meldah and Kutter improved the original apparatus, adapting it to the kind of ant under observation. We have all seen the plaster nests of Charles Janet in the public exhibitions. They are highly practical, but are suitable mainly for the smaller species.

These plaster nests, which reproduce as faithfully as possible the arrangement and the meanderings of a natural formicary, permit us, in particular, to note the spirit of organization and adaptation displayed by the ants under circumstances of a wholly abnormal and unexpected character, and above all, the meticulous

cleanliness which they maintain in their nests. For example, in a Janet nest which was inhabited by a small colony of *Solenopsis fugax*, and which consisted of thirty-three chambers, fourteen were reserved for nymphs which were nearly mature. One contained, on one side, nymphs in a less advanced stage, and small larvæ; seven contained larvæ of medium size; five were filled with the enormous larvæ of the winged *Solenopsis;* one chamber was occupied by the queen; four were left unoccupied, and one single chamber, in the driest portion of the nest, and the furthest from the entrance, served as the refuse-dump or cloaca. Here the workers shot their refuse, including the sacs which the larvæ discard at the beginning of their nymphosis, and which contain the residue of the food consumed since hatching. Other nests of larger dimensions contain two or three cloaca, and since the excrement of ants is always liquid, the special tint assumed by the plaster of one of these retreats plainly betrays its exclusive

function. Thus, in their prison, having no communication with the outer world, they improvise sanitary arrangements which our human engineers could hardly better under such difficult circumstances.

The least complicated form of apparatus, and the most convenient for elementary observations, is that employed by Lubbock. It consists of two glass plates, some eight or twelve inches square, separated by an interval of an eighth to a quarter of an inch, according to the species under observation: that is, an interval just large enough to permit the ants to move about freely. These plates are enclosed by a wooden frame, the interval is filled with finely-divided earth, which is slightly moistened, and the whole is covered, since the social insects are accustomed to live in darkness. A number of these nests may be arranged on a single support, care being taken to surround this with water, or better still with finely-powdered plaster, in order to prevent escape.

Thanks to such apparatus, the secrets of the formicary have been discovered; or at all events, most of its material secrets. As for the rest—the political, economic, psychological and moral secrets—we are still very far from deciphering them.

WARFARE

WARFARE

I

THE ants, alone among the insects, have organized armies and undertake offensive wars. The termites have their soldiers, but these soldiers never attack. They are employed exclusively in the defense of the termitary, or in protecting the unarmed workers when they forage in the neighborhood of the fortress. Among the bees, similar aggression, properly speaking, is unknown. Sometimes, it is true, an enfeebled or disorganized hive, or one whose honey has poured or oozed away owing to a broken comb, or to some internal catastrophe, may excite the cupidity of its neighbors, and tempt them to pillage. Then indeed there are more or less violent affrays between the defenders and the thieves; but these are accidental brawls rather than actual battles. Apart

from such exceptional instances an absolute respect for life and property prevails in the world of the bees.

This is by no means the case in the world of the ants. Generally speaking, ants are pacific. But the very form of their more refined civilization almost irresistibly incites the more intelligent species to make war upon less bellicose and more docile races, association or alliance with which has become almost indispensable to them. In this they are strangely like the highest human civilizations; as though the morality of the world, of nature, of Providence, or of the spirit of the universe had decreed that such things should be in default of a better dispensation.

II

For the rest, the physical and moral polymorphism of the ants is infinitely more extensive and more varied than that of the termites, the bees, and human beings. From the most primitive of the ants—the *Ponerinæ*, which are

directly descended from the unknown proto-ant of the first geological ages, and whose activities are still individual—to the most advanced species—the fungus-growing ants, the slave-owning ants, and the weaving ants; from the most inoffensive and pacific species, which never defend themselves (*Formicoxenus* and *Myrmecina*), to the most valiant (*Polyergus rufescens*, *Dorylinæ* and *Ecitoni*) which never retreat, there are many more stages of development, many more transitions, than between the most brutish of our Polynesians or Tierra del Fuegans and the great white nations which lead the human species. Form, size and color differ as greatly as habits and intelligence. For example, *Polyrhachis appendiculata* of Australia—whose thorax consists of two plates like flattened nuts surmounted by a great button of jet, and terminating in a heavy amber-colored capsule—set beside *Orectognatus sexspinosus* of the same continent—which has a head like a horse, set above a laminated and a spiny corselet, into

which is inserted a long, thread-like tube, terminating in a transparent pear—seem as mutually alien as the hippopotamus and the grasshopper; while *Tetramorium cœspitum*, which dares to attack *Formica pratensis*, is like a polecat assailing an elephant.

It is natural that the weapons of the ants should differ as greatly as their bodies. As offensive weapons all the ants possess mandibles, whose aspect, always rather monstrous, is excessively varied. They form pincers or shears, some short and curved like a dentist's forceps, others long as reaping-hooks, ending sometimes in a sharp point which is capable of instantly piercing an enemy skull. There are some whose twin toothed cutting-edges enable the ant to saw through the necks, legs or thorax of the adversary; while others possess two pairs of imbricated jaws. In addition to the mandibles, there are species which are provided with a sting and a poison-bag comparable to those of the bees; but this weapon is tending to atrophy.

It is generally replaced by an anal pouch, a sort of vaporizer, capable of projecting to a certain distance a cloud of poisonous drops which paralyze or lame the antagonist. They seem, however, reluctant to use this weapon, which they employ only in cases of urgency and in serious engagements; perhaps because they do not desire the death of the enemy, or because they fear that the use of this light artillery possibly may recoil upon themselves; for they are often poisoned by their own venom.

III

It is equally natural that the warlike habits of the ants should vary as greatly as their bodies and their weapons. Every kind of warfare known to ourselves will be found in the world of the ants; open warfare, overwhelming assaults, levies *en masse*, wars of ambush and surprise and surreptitious infiltration, implacable wars of extermination, incoherent and nerveless campaigns, sieges and investments as wisely

ordered as our own, magnificent defenses, furious assaults, desperate sorties, bewildered retreats, strategic withdrawals, and sometimes, though very rarely, brawls between allies, and so forth. We will not attempt to enumerate all the forms of warfare practiced by the ants: too meticulous a description would be tedious, and would be more proper to the technical monographs, where the reader may readily find it. But from this inextricable tangle a few general laws emerge which give a particular character to their hostilities.

To begin with, contrary to the assertion of a legend as hoary as that of their egoism, the majority of species, as I have already stated, are resolutely pacific; which does nor prevent them, when they are attacked, from displaying, in the defense of their community, a courage which is almost always superior to that of our most heroic troops. They rarely take account of the number or size of their assailants. However, in the face of their threatening attitude the

aggressor often abandons his designs, or after the shock of the first encounter beats an unashamed retreat.

However powerful and well-armed and formidable they may be, these pacific species commonly respect the property of others, do not abuse their strength, avoid all occasion and cause of conflict, and concern themselves discreetly and exclusively with the affairs of their own formicary. *Neomyrma rubida*, for example, the most terrible of European ants, equipped with a deadly sting, is never known to attack other colonies.

IV

Unfortunately for the peace and happiness of the world of ants, there exist, as in the world of men, a certain number of races, generally the wealthiest and most powerful, which have not the same scruples, and which, without making war their exclusive profession, find it perfectly natural to seize that which does not belong to

them; and, above all, by means of periodic raids, to carry off, before birth, so to speak, the entire youth of a neighboring community, in order to reduce it to slavery. We note with regret that the most civilized and most intelligent species are likewise the most dishonest.

Here, I ought, as is customary, to reproduce an account of one of those battles between ants which have been so conscientiously observed and described by Huber: for example, an expedition of Sanguine or Amazon ants. And indeed I could not do better. Unfortunately, they are too long, and at the same time so coherent that one does not know how to abridge them. I will therefore refer the reader to the original text, which will, I believe, be republished before long.

Among these bellicose ants the Sanguine ant (*Raptiformica sanguinea*) is very common in Europe, and is found, as a rule, beneath hedges with a southern aspect. Viehmer, Wasmann,

Wheeler and Forel have made it a subject of special study. The Sanguine ants undertake two or three slave-raids every summer. The strategical organization and general conduct of these expeditions could not be bettered. Here is the description of such a raid as observed by Forel, whose account, since it is at times over-detailed and a little diffuse, I have taken the liberty of abridging:

Having sent out scouts to reconnoiter the nest of another species—in this case a nest of *Glebaria*—which they proposed to pillage, they set forth one fine summer morning, advancing in small bodies, and gradually encircled their objective. Being alarmed, the besieged *Glebaria* crowded round the entrances, barricading them as best they could with grains of sand, which for them represented heavy blocks of stone. Then, at a signal, as to whose origin we know nothing —for the source of such orders is even more mysterious than in the hive or the termitary— the assailants rushed forward in a massed at-

tack. The defenders attempted assistance, but being over-run, hustled, and overthrown, they reëntered their nest in despair, to emerge again carrying their nymphs, which they were resolved to save at any cost, and whose number was so great that in a moment the color of the mêlée was changed from tawny to white. But the aggressors tore their treasures from them, storing them, provisionally, near the entrances of the nest, allowing the fertile mothers and the unencumbered workers to pass, but, like inflexible customs officials, compelling all those who were carrying nymphs or larvæ to lay down their burdens. Yet all this time they did not do the slightest harm to those who offered no resistance, or refrained from defending themselves with poison.

Having captured a few *Glebaria* who had succeeded in escaping and hiding a certain number of their nymphs in the grass, they seized the latter, and presently established, between the pillaged town and the victorious city to which

the living booty was transported, a continuous line of workers going and coming, and in three days' time the invested formicary had been completely despoiled.

Contrary to what one would be inclined to imagine, there are no massacres of the besieged during these raids, and very few victims are left on the field. The occupants of the nest are simply expelled, and migrate, never to return to their home, which, once the nymphs are removed, is abandoned by the conqueror, and soon falls into disrepair. In accordance with myrmecæan principles, the necessary operations are accomplished with as little damage as possible to others.

On the threshold of their new home the eggs, larvæ and nymphs of the raided *Glebaria* are received by slaves of their own race, who tend and feed and rear them until they too are able to serve in the house of the conqueror. It is thus that the servants are recruited in the world of the slave-owning ants.

V

As a matter of fact, their condition is not one of actual slavery, and Huber, more than a century ago, considered that the word was out of place. What we call slavery is rather an interested adoption, which before long is transformed into a sort of foster-maternity. But, contrary to reasonable expectation, it is the conquered who adopt their conquerors, and the latter become the children of their victims, to such a point that in certain over-civilized colonies they are no longer capable of taking nourishment without assistance. These voluntary slaves are as free as their captors; they leave the nest when they choose, go and come as they please, are faithful unto death to their masters, and if need be fight at their side against the very stock from which they issued. This need does not occur in normal life, since the *Glebaria* are essentially pacific; but it may easily be evoked by artificially embroiling two rival

colonies. It is probable that in these domestic relations the mysteries of regurgitation, and the secret joy of the giver, play a preponderant part.

In the nests of these Sanguine ants (*Raptiformica sanguinea*), which are found from Scandinavia to Italy, and from England to Japan, servitude is not always organized in the same fashion. One nest, for example, may contain more slaves than masters, while another may possess only a few, and yet another will have none at all, replacing them by small workers; and lastly, some nests contain slaves of two species—*Glebaria* and *Rufibarbis*—who live in mutual amity. Forel was even able to induce an artificial nest of Sanguine ants to adopt and rear eight different species: namely, *Serviformica glebaria, Rufibarbis, Cinerea, Formica pratensis, Formica rufa, Formica exsecta, Pressilabris* and *Polyergus rufescens*. Each of these species did its work after its own fashion; *Exsecta* and *Glebaria* were extremely industrious; *Sanguinea*

was very skillful, *Pratensis* very clumsy, and *Polyergus* incorrigibly idle. Representatives of other races, being regarded as unadaptable and useless, were promptly put to death.

In the nests of certain slave-holding ants the alliance between masters and servants is even more singular. An ant observed by H. Kutter, which bears the barbarous name of *Strongylognathus alpini*, when undertaking an expedition against *Tetramorium cæspitum*, sends its slaves into battle, and without taking part in the conflict, contents itself with looking on and intimidating the adversary by its mere presence. On the other hand, *Strongylognathus* and *Tetramorium* if subjected by man to abnormal conditions although hereditary enemies, no longer attack one another, but even form an alliance. All these facts demonstrate the extraordinary suppleness, the ability to make the best of circumstances, the easy power of adaptation, and in a word, the intelligence which animates and

guides the world of ants—a world which we have hardly begun to study, and of which as yet we understand but little.

VI

Be it noted that in all the foregoing cases the servitude is unconscious. The *Glebaria* and *Rufibarbis,* which are easily conquered, are unaware of their slavery, since they are carried off in the embryo state, and have never known their native community. That they should adapt themselves to their life is therefore natural enough. Of all the raptorial species, only the formidable *Strongylognathus Huberi* captures adults and reduces them to slavery. It does not appear that the results of this hazardous operation are seriously unsatisfactory, or it would in all probability have been abandoned long ago.

Nevertheless, these practices, which might be qualified as super-animal, have at times very singular consequences. Wasmann cites, amongst

others, a case in which some Sanguine ants had carried off the cocoons of a small colony of *Pratensis*. After the cocoons had hatched, the young *Pratensis*, foraging in the neighborhood of their new home, found their own mother, and led her to the nest of their masters, in order to replace the Sanguine queen, who had just died; so that the original colony gradually became a republic of *Pratensis* or field ants. A civilization so refined and complex is necessarily subject, like our own, to unexpected consequences.

VII

But the great slave-holding ant is *Polyergus rufescens*, the Amazon ant, or Legionary ant, as Huber calls it. It is comparatively rare. For other species slavery is a luxury; for the Amazon it is a vital necessity. The proportions of slaves and masters are accordingly reversed. In a Sanguine nest there is, generally speaking, one slave to six or seven masters; whereas each Amazon has six or seven slaves. The evolution

which begins in the nest of the Sanguines is here perfected. The Amazons, by reason of their sickle-shaped mandibles, are, like the soldiers of the termites, fitted for nothing but warfare. They cannot eat without assistance, for they cannot take any nourishment save from the mouths of their servants. They are as little capable of rearing their young as of building or repairing their nest. In the depths of their lair they pass their time in besotted idleness, rousing themselves only in order to polish their armor, or to pester their slaves for a mouthful of honey. Without their servants these magnificent warriors, with their bronze armor, these superb shock-battalions, these irresistible veterans of great campaigns, are as impotent, as utterly helpless as so many suckling infants. Into the midst of these helpless creatures, who would die of hunger though surrounded by all the wealth of a beehive, and who piteously demand of one another the regurgitation which they are powerless to grant, introduce, as did

Huber and Forel, a worker of the ancillary species, and all is changed: she is like a good housekeeper in a den of starving old bachelors. Hurrying forth, she begins by filling her crop, in order to give food to those who are dying of hunger; then she assembles the eggs and larvæ and nymphs, on which she lavishes the needful care, and finally she cleans and repairs the nest. In less than an hour the great-hearted little servant has completely restored order in the unhappy community, which has no means of livelihood but the profession of arms.

VIII

For organic reasons, then, war is the sole trade of the Amazons, and is thus a matter of life or death. At any cost they must constantly recruit their slaves. Whatever the number and size of their adversaries, they attack with frenzy, never retreat, and aim only at the head. Their habits, being exclusively warlike, have resulted in a fixation of instinct, so that their

tactics have neither the suppleness nor the intelligence to be observed in the Sanguine ants. Nor have they the clemency and amenity of the Sanguines, which recoil from inflicting a mortal wound unless victory cannot be secured by other means. In order to wrest the coveted prey from a *Rufibarbis* worker, the Sanguine ant merely hustles her; the Amazon promptly decapitates her, and carries off the head still attached to the cocoon. Sometimes, in the heat of the fray, the Amazons are overcome by a veritable frenzy; they run amuck, tearing to pieces everything that falls into their mandibles—larvæ, nymphs, splinters of wood, their comrades-in-arms, and even their slaves, when these endeavor to calm them. But the courage of these warriors is unequaled, and sixty of them will put to flight an army of Sanguines, although the latter are notable strategists and redoubtable brigands, by no means lacking in courage.

For the rest, as Huber was the first to observe, the tactics of the besieged party are not

the same when the assault is made by the Sanguines as when it is delivered by the Amazons. This observation of his applies more especially to the victims which he calls the Gray-Black Ants: for at the close of the eighteenth century the ants were not yet afflicted with the barbarously scientific names which they bear today. They were known, simply and familiarly, as the Sanguine Ants, the Mining Ants, the Russet Ants, the Amazons or Legionaries. Now the Amazon has become *Polyergus rufescens*, and the Gray-Black Ant is *Formica fusca*, of the race of the *Glebaria*.

When the attack is made by the Sanguine Ants the first impulse of the besieged community is to save the larvæ and nymphs by collecting them at the entrance of the nest farthest from the point of attack, so that they may be more readily carried off in the event of defeat. This done, the defenders hurl themselves heroically into the fray, defending their territory inch by inch, and so effectively that the assail-

ants often give way in the end, and quickly retreat, carrying off their booty.

But when an attack of the Amazons is signaled the Gray-Blacks understand that all resistance is useless, and that they are dealing with an overwhelming and pitiless enemy. The entire garrison is overcome with an apathetic consternation, whose only hope lies in satisfying the aggressors.

Forel estimates that a colony of a thousand *Polyergus* every year captures, on an average, forty thousand cocoons of *Fusca* or *Rufibarbis*.

IX

Here is a curious point, in which the ants resemble certain human races: the brutality and the probably stupid exactions of the slave-holding ants appear sometimes to exhaust the patience of their slaves. Forel—for there is nothing that he has not seen—once witnessed one of these servile rebellions. The Spartacists of the subterranean kingdom seized their mas-

ters by the legs, bit them, and carried them far away from the nest. Protected by their cuirass of chitin, the Amazons submitted to this treatment quietly enough, and did not retaliate unless they were pushed too far. They then would take the head of an insurgent between their terrible sickles, and perforate it at a stroke if the slave did not release her hold.

Stupid though they appear to be in their method of making war, the Amazons sometimes have remarkable ideas. They have been known, for example, on finding themselves overcrowded in their home, and having discovered an abandoned nest, which they considered to be more comfortable than their own, to transfer all their slaves thither, settling down with them in the new nest after some hours of journeying to and fro.

There are Amazons in America and Japan which have almost the same habits as our own species, and enslave ancillary races, which bear unfamiliar names. There is nothing to be

gained by enumerating them here. The *Polyergus breviceps* is distinguished from all her kind by her perfect courtesy. She never inflicts the slightest violence on those species whose children she carries off.

X

Territorial wars are less brutal and less desperate than the raids of the slave-holding ants. The ant has as definite a sense of property as any human being. This is not confined to the nest and its contents, but extends to the area which she frequents and searches for forage, and above all to the reservations on which her aphides are pastured. She will not permit the emissaries of a neighboring colony to enter her territory on marauding expeditions, or to steal a drop of the honey-dew secreted by the plant-lice which she rears, parks, stables and tends. We find here the same contradictions as in the case of man. We permit no one to take what belongs to us, but we are willing enough to take

what belongs to other people. This inconsistency gives rise to many conflicts, which are, however, less frequent, less cunning, and less complicated than our own. We shall return to this subject in the chapter devoted to aphidian cattle.

A more special kind of warfare, since it is waged only by the tropical species, is war upon the termites. This is a purely alimentary warfare; or perhaps it should rather be described as hunting. The unfortunate termite, redoubtable and ingenious when confronting other enemies, is the providential prey, the destined victim of the ants, which in certain regions passes a good part of their life in watching for the opportunity of making their way into the termitary. This opportunity very rarely occurs, thanks to the precautions taken by the vigilant defenders. I will refer those who are interested in the details of these conflicts to an excellent little works by M.-E. Bugnion, entitled *La Guerre des Fourmis et des Termites.*

XI

In the world of the ants, as in our own, a war is not necessarily terminated by the extermination or flight of the defeated army. The ants are as well aware as ourselves of the benefits of armistice and peace, and the advantages of alliances. Most of the reactions observed in this connection have been artificially produced, for in the natural state they must be somewhat rare, and they take place far from human observation. None the less, they demonstrate once more that the intelligence of ants is very closely akin to that of man.

Ants of the same species, but coming from two different nests, if thrown pell-mell into the same artificial formicary, attack one another furiously at first, but they undoubtedly realize the uselessness and imbecility of a fratricidal conflict, for presently their excitement abates, their mandibles relax, the combatants fall apart, and a sort of diffused peace makes itself felt,

which soon becomes an alliance that nothing can shake; and the sometime enemies, as though they were members of the same family, set courageously to work in the new home which has been imposed on them.

When the ants are of different species peace is less rapidly established. Of this we can readily convince ourselves by repeating the experiment of Forel, placing, for example, in the same bag a colony of *Sanguinea* and one of *Pratensis*. The bag having been shaken in order to mix the ants thoroughly, it is emptied into an artificial formicary. At first there is a scene of the greatest confusion; then a battle commences which continues until the evening, gradually diminishing in virulence, and finally degenerating into inoffensive scuffles and half-hearted threats. A few Sanguines and a certain number of *Pratensis* commonly lose their lives in the battle. It is, however, an astonishing fact that the losses of the Sanguines are never greater than those of their enemy, for the *Pratensis*

have a formidable poison at their disposal; but it is evident that they are reluctant to make use of it.

Two or three days later peace is definitively concluded, and the whilom enemies help one another to carry larvæ and nymphs, and work together like sisters in the improvement and upkeep of their new home.

This concord is so complete that it even affects the architecture of the nest, for, as we have seen, each species of ant has its own style; that is, its own fashion of selecting, triturating and disposing of the materials of the house which it builds for itself; and this, of course, is why in a state of nature the dome of a mixed nest is not precisely like that of a nest of unmixed *Sanguinea* or *Pratensis*.

This influence of allies, auxiliaries or slaves does not stop short at the architecture of the nest, but extends even to the character, and modifies, in a greater or less degree, the psychology and morality of the formicary. For

example, as was noted by Ernest André, the Amazons, when served by the timid *Formica fusca*, become gentler and more reserved and deliberate in their movements, while the lively and resolute *Rufibarbis* inspires her masters to greater activity.

XII

To these bellicose ants I must add the large and formidable Visiting or Driver Ants of South Africa, Guiana, Mexico and Brazil: the *Dorylini*, *Ecitini* and *Leptanillini*. They do not wage war, in the proper sense of the term, because nothing can resist them, and they never—any more than a tornado or a typhoon—encounter an adversary who dares to oppose their progress.

The *Dorylinus anomma* of Africa, somewhat recently observed by J. Vosseler, is—like the *Eciton hamatum* studied by Hetschako, W. Muller, Datu, Belt, Bar and others—an enormous blind ant, exclusively carnivorous, whose only trade is massacre and pillage. The

Anomma do not found communities, but establish camps, or rather bivouacs, along their paths, being necessarily nomadic, since they quickly and completely devastate the areas in which they sojourn.

Their predatory expeditions are organized in a military and methodical fashion. They are preceded by a few scouts, but before long, in their impatience to begin their work of pillage and carnage, they surge out of the crevices of the soil and inundate the plain or jungle. Advancing at a run, their ranks are enclosed by two living hedges of officers with large heads and hooked mandibles, who protect and guide and control them, and, at the least alarm, fall upon the enemy. In order that nothing shall escape them, they send forth detachments of foragers on either hand. The movements of these armies, which represent, in the world of insects, a cataclysm comparable to that which would be caused by the release, in a world of defenseless quadrupeds, of a horde of more

than two million wolves—for this is the figure reached by the most moderate estimates—results in a universal and indescribable panic, which is often proceeded by flights of birds. All living things that cannot flee are instantly massacred. A prey too heavy to be transported is dissected on the spot, and the morsels are carried off to the general store. If the *Anomma* find a hen-roost in their path, or any of the smaller mammals, they leave only the bones of their victims. At Tonga a caged leopard was killed and stripped of its flesh in the course of a single night. In the old days such prisoners of war as were not considered comestible were delivered over to these ants, being first bound hand and foot, and in a few hours the *Anomma* reduced them to osteological specimens worthy of our museums; for since they cannot see they attack man as they attack any other creature. If you wish to remain in your house when the *Anomma* are on the warpath, or if there is a sick person in the house who cannot be removed,

you may stand the legs of your bed in bowls of vinegar, taking care that there are no cracks in the ceiling, otherwise the ants will drop down upon you. But it is more usual to make way for them, since their mandibles, even when detached from the body, do not release their hold, and the natives employ them as surgical clips for suturing wounds, for they will hold the lips of a cut in contact until it is healed.

After the passage of the *Dorylini*, as after the passage of their American sisters, the *Ecitini*, no living creature is left. When they take a village by assault they devour bird, beast and insect; on the other hand, since they cleanse it of every trace of vermin, the inhabitants, who make their escape in good time, are obliged to recognize that their misfortune is not without its compensations.

Some of these raids, when the country is totally devastated, are rather migrations. Here again the *Dorylini* have the same customs as the *Ecitini;* they carry with them their eggs,

larvæ and nymphs, and on making a halt they shelter them in provisional nests. But since the larvæ of the *Dorylini* are very sensitive to the heat of the sun, they are transported along covered ways, or in the shade cast by the soldiers, whose serried heads and bodies form veritable tunnels. A provisional nest of *Ecitini*, discovered by Bar, near Cayenne, had a capacity of more than a cubic yard, and contained hundreds of thousands of workers, whose interlaced bodies formed enormous balls, which maintained the necessary heat around the cocoons.

This formation of living balls to protect the brood is practiced by both species in case of torrential rains or sudden floods, or when it is urgently necessary to cross a stream. Is it explained by a mere reflex, or is it a deliberate and heroic act inspired by supreme distress? The accumulation of the cocoons in the center of the compacted mass can hardly be imputed to chance.

COMMUNICATION AND ORIENTATION

COMMUNICATION AND ORIENTATION

I

HOW do ants, which are almost blind, know that they are dealing with a stranger when they meet in their nest a member of their own race, but of another family? This is one of the most obscure and complex problems of the formicary. A patient and ingenious myrmecologist, Miss Adèle Field, has given years to the study of this problem without arriving at a wholly satisfactory solution. Her experiments lead her to believe that the olfactory sense, which in the ant is predominant over all the rest, resides mainly in the last seven segments of its funicle—that is, the process at the end of the antennæ. Each of these joints is consecrated to a particular odor: for example, the odor of the nest is perceived by the last segment; the last

but one discerns the age of the workers in colonies consisting of various families of the same species; and the last but two perceive the scent with which the ant impregnates her own trail. When the last segment is removed the ant will enter any nest, and will in consequence be killed: when the penultimate segment is amputated she can no longer recover her own trail. By another segment the effluvium of the queen-mother is recognized, and the worker deprived of this segment will pay no further attention to the queen or her offspring. Another segment is reserved for the perception of the odor of the ants' own species; when it is suppressed the most varied species may be mingled without conflict.

Note that the odor of the nest is not identical with the odor of the species; the first odor is variable, depending on the age of the inhabitants and other circumstances; the second is almost indelible. The hereditary odor, again, is different; it is the maternal odor, which every

ant bears from the egg until the day of her death, and which must not be confounded with the odor of the queen, who may not be the mother of the ant in question.

But it would be rash to declare that the olfactory sense of ants is confined to the antennæ. It is, on the other hand, quite possible that this sense is not localized in an organ, as with us, but, as in other insects, is distributed all over the body. Minnich has recently proved that butterflies smell with their legs: to be precise, with the four terminal portions, tarsal and distal, of the basitarsi of the second and third pair of legs. According to Wheeler this form of sensory reception is probably quite frequent in the insects. It is thus useless to distinguish between perception of odors at a distance and perception of taste by contact, for insects utilize their antennæ for both purposes, and also to perceive tactile sensations.

We must further consider the life of odors in the memory of the ant. This is variable; in

some cases it persists for ten days or so, in others for as long as three months, and in others—and notably when the hereditary odor is in question—it may survive for more than three years. Add to this the inevitable mixtures and superimpositions, and above all add the electric, magnetic, and perhaps etheric or psychic perceptions of these inexhaustible organs, and you will see what incredible complications await the simplest investigations of this little world—a world which we regard as much simpler, much more rudimentary, much poorer in heredity, much less interesting and less rich in the unexpected than our own.

II

The antennæ, which in the ants take the place of eyes, since the sight of ants is so feeble that many are practically blind, serve also as organs of speech. We have all watched the ants going and coming along the paths surrounding their nest. Whenever two ants meet, they almost in-

variably tap one another rapidly with their antennæ, as though they had something to say. Have they no other means of communication? It is certain that the alarm, when a formicary is attacked, or merely disturbed, is propagated with such lightning-like rapidity that we are almost compelled to explain it by a complex of cellular reactions, instantaneous and unanimous, such as occurs in our own bodies when they are seriously threatened or injured. But in addition to these collective reactions there is incontestably an individual antennal language. Sir John Lubbock made minute and conclusive experiments in this connection; and here is one which may readily be verified. Two little saucers are placed at equal distances from the formicary; in the first are deposited fifty larvæ or nymphs, and in the second, three or four; then an ant is placed in each saucer. Immediately each ant seizes a larva and carries it to the nest. The larvæ are replaced as they are removed; and presently it will be seen that three or four times as many

workers come to the saucer containing the fifty larvæ as to that which contains only three. The ants must, therefore, have succeeded in making their comrades understand that there was more urgent work to be done in one direction than in the other.

Here is another experiment of Lubbock's. He had been observing a little *Lasius niger*, who was constantly occupied in carrying larvæ into her nest. At night he imprisoned her in a phial, releasing her on the following morning. She immediately resumed her labors. He imprisoned her again at 9 A.M., and at 4 P.M. released her in the neighborhood of her larvæ. She examined them with great attention, but returned to her nest without taking any of them. At the moment, no other ant was outside the nest. In less than a minute she returned with eight of her friends, and the little troop went straight up to the heap of larvæ. When they had covered two-thirds of the distance the observer again imprisoned the marked ant; after some minutes' hesi-

tation the others returned to the nest with remarkable promptitude.

At 5 P.M. he laid the marked ant on the larvæ; she once more returned empty-handed to the nest, but after remaining there for a few seconds she returned with thirteen companions. They must all have been informed of the presence of the larvæ, and otherwise than by example, since they had never seen the marked ant carrying a larva.

Are such communications made by means of the antennæ alone? Very probably; and indeed, almost certainly; but we cannot employ a counter-test, since an ant whose antennæ have been amputated loses her sense of direction, and cannot find her way either to the larvæ or to the nest.

III

In addition to these experiments, which established the fact of communication, Lubbock made many others, continuing them for days at a time,

and recording minute by minute all the actions and movements of various *Lasius* workers in the presence of larvæ. He tells us of one, for example, which between 9 A.M. and 7 P.M., when he ceased to observe her, made ninety return journeys from the nest to a bowl containing larvæ. On each journey she carried off the larva, and she always returned alone. Others, under the same circumstances, made fifty, eighty, or more journeys, and were never accompanied. Did they consider it superfluous to advise their companions, feeling that they were equal to the task? On the other hand, the experiment with the 70 pins gave results of a very ambiguous nature. It would take several pages to describe this experiment in detail; it will suffice to explain that of 70 pins thrust into a dish of cork, 3 bore, at their heads, little scraps of cardboard smeared with honey. The final statistics, at the end of five days, showed that of 157 ants 104 went to the pins carrying the honey, and 53 to the 67 pins which were not baited with honey. But is it not

probable that the ants that went to the honey were guided by their sense of smell, which is, as we know, extremely subtle?

IV

The antennal language must be elementary in the extreme. This is proved by the fact that when the ants cannot make themselves understood they have recourse to example and direct action. They forcibly drag along those whom they wish to convince, compelling them to cover the path which they will have to follow, and showing them what they are to do by doing it in their presence. Another thing which proves that it is by no means complicated, and is properly speaking no more than an exchange of sensations, is the fact that the parasitic insects, and notably certain coleoptera which exude secretions of an intoxicating nature, though they have nothing in common with the ants, whom they corrupt, living sumptuously at their expense, are able to speak this language and understand it as

well as their hostesses. Obviously we must not exaggerate the importance of a language which is so easily understood. Nevertheless, the examples already cited, given by Sir John Lubbock, which are only a few of many, show that we must not underestimate its resources.

For the rest, the problem of communication is one of the most exasperating problems of the formicary. Under certain circumstances, when the construction or defense of the nest is in question, or the distribution of labor, or military operations, or the tending of the larvæ, or the highly complicated culture of fungi, or the maintenance, herding and defense of aphidian cattle, or the formation of a chain by the weaving ants in order to hold in place the recalcitrant edges of a long leaf, we are amazed by a unanimous and instantaneous coöperation, which seems as though it can only be explained by the ants' capacity for making themselves understood, giving and receiving orders or advice, and following a common plan.

But apart from these instances, and above all in the handling of a burden, we often perceive in the ants an incoherence, an agitation, of so stupid and futile a character, a lack of common sense so bewildering, that we are inclined to question their intelligence. As a result of patient and protracted experiment, an accurate, reliable observer, V. Cornetz, came to the conclusion that there is no coöperation among the ants, that far from helping one another they persistently hinder and oppose one another, and that what we call "the spirit of the formicary" does not manifest itself outside the nest—at any rate, when heavy and awkward burdens have to be transported.

We have only to observe what happens in the vicinity of the ants' nest in order to convince ourselves that he is right. Yet those who insist that there is agreement and coöperation are not mistaken. Whom are we to believe? It is quite possible that the ants do lose their heads when they have to move certain objects, just as it is

possible that in the eyes of an observer who might observe us from as great an altitude and as blindly as we observe the ants, we too would appear to be running hither and thither like madmen in circumstances when we seem to ourselves to be behaving most reasonably. There are certainly many things in our conduct and our civilization which would be quite incomprehensible to such an observer, and which are really pointless. But this bewilderment and confusion when burdens have to be carried is only temporary. Continue to observe them patiently, and you will see that the ants always end by achieving their purpose; that the sliver of straw, the splinter of wood, the over-large insect which they want to carry into the nest always does find its way thither.

These failures of intelligence, these incoherences and anomalies, always astonish the observer. But do they not experience, on their own plane, the very difficulties that we too experience when confronted by the treachery and

the ill-will of nature, which to us also is inexplicable?

The chief conclusion to be drawn from these observations, as from many others of a different order, is that ants, in a body, often display a kind of genius, but that when isolated, and no longer inspired by the collective soul, they lose three-fourths of their intelligence.

This is all we can say until the problem has been more closely studied. And in the meantime, let us remind ourselves that if we cannot solve such petty problems, the whole of whose data could be held in the hollow of the hand, there is a certain arrogance in imagining that we have found the solution of those which are hidden from us in the depths of the firmament.

V

The problem of mutual assistance and co-operation gives rise to another, which leads us to consider the morality of the formicary. The earliest observers—Latreille, Lepeletier, Saint-

Fargeau, and others—declared that they had seen ants helping their mutilated comrades, and nursing and tending the sick and wounded. Forel, a more circumspect observer, tells us that although the ants seem to show some concern for slightly wounded comrades, those who are seriously injured are carried out of the nest and left to their fate. Sir John Lubbock, who in this connection carried out the most methodical experiments, states that the workers are more often than not quite indifferent to the fate of their comrades, and that it does not occur to them to go to the rescue when their companions are limed in a pool of honey, or half drowned, or buried under a landslip, although a little assistance would save their lives.

This indecision and uncertainty make them seem more akin to ourselves, and alienate them from the bees and termites, which are without exception utterly indifferent to the misfortunes of others. The bee ruthlessly throws her dying sisters out of the hive; the termite instantly de-

vours its dead; while the ant, showing more restraint than human cannibals, does not eat even the bodies of her enemies.

In the formicary, as in our human cities, among those who pass by there is sometimes a good Samaritan. Are such individuals rarer or more frequent than with us? On this point the myrmecologists differ; at all events, rare cases of benevolence do seem to occur, and this fact is assuredly more extraordinary and more disconcerting than if charity were universal and instinctive; for then we should be compelled to refer it to the behests of organic law, which would render it inevitable and automatic, and would rob it of all merit, and all relation to the human virtue.

I will not here refer to facts which are, I believe, sufficiently well known, and which are recorded in the works of all the myrmecologists. I am alluding to the little *Fusca* born without antennæ, attacked by strangers and picked up by her compatriots, who carry her back to the nest;

to the unfortunate ant lying on her back and unable to turn over and feed herself, who is rescued by her comrades; to helplessly intoxicated workers (the victims of our experiments) who are led home to the formicary; to the *Lasius* queen, accidentally crushed, whom her subjects continued for weeks to tend as though she were still alive. Huber, for that matter, had already noticed that five or six workers remained for several days beside the royal corpse, constantly brushing and licking it, "either," he gracefully added, "because they still retained some affection for their sovereign, or because they hoped to resuscitate her by their attentions."

These examples, to which I might add those given by Ebrard, and on which no one, having regard to the rank of the observers, has ever cast any doubt, seem to prove that more good Samaritans pass along the tracks of the formicary than along the road from Jerusalem to Jericho, which is by no means the least frequented of our human highways.

For the rest, it would be as well to examine each of these cases more closely. The instances of the little *Fusca* born without antennæ, the ant lying on her back, and the helplessly intoxicated workers, tend to prove that the ants, as Forel has remarked, show concern only for sick or wounded comrades who may still render some service to the community. As for the crushed queen, and the queen of whom Huber writes, it is quite possible that the workers surrounding them did not for some little time realize that they were dead.

Nevertheless, let us accept these examples, and ask ourselves how far we can admit the early anthropomorphic interpretations. Pity and charity exist nowhere in nature save in man, in whom they are probably the result of an investment made by his egoism, to be repaid, with high interest, in a future life. It is not for us to cast a stone at him. He obeys a formal command, inscribed in every drop of his blood; and all living creatures, except the ant, and up to a

certain point the bee and the termite, can do no otherwise if they would conform to the supreme, universal and eternal law, which is to persevere in living. Before the belief in a life beyond the grave died or lost its power, charity had time to transform itself into an inherited habit, which became a sort of sub-instinctive luxury, somewhat intermittent in its emergence, and whose manifestations, though often admirable, are not very frequent. What shall we do when this reserve is exhausted? Shall we find another reason for loving one another, and occasionally putting our neighbor before ourselves? It is possible, for everything happens sooner or later; but we do not seem to be looking for this reason, and in the interval, which may be protracted, humanity may perhaps exterminate itself, or at least be so spoiled and damaged that it will have to begin all over again.

As for the ant, she would evidently resemble the man who expects nothing of heaven or hell,

were it not that she has her regurgitative charity, which is a joy, and her religion, which is the love of the whole of which she forms a part, without which she does not exist, and which represents her own life, enlarged and multiplied. How far is this sentiment akin to what we call charity? It is, of course, impossible for us to say.

VI

Since we are now considering difficult problems, let us approach yet another, equally delicate: the problem of orientation or direction.

We know that many animals, and notably the homing pigeons and the migratory birds, possess a special sense, which enables the first to find their way back to their cotes over distances of hundreds of miles, and the second to return to their nests, or their habitual places of sojourn, across the seas, in another continent. The scientists today are almost agreed in localizing this sense in the semicircular canals of the inner ear, which are supposed to play the part of radio-

gonemetric receivers; or in other terms, to capture certain waves, some of which are known to us, while of others we as yet know nothing.

Some terrestrial animals—for example, the horse—and even human beings—notably the Eskimos and the nomads of the Sahara—are said to possess an analogous power, though in them it is less developed. Must we attribute this also to the semicircular canals, or to a faculty which has been denominated "Exner's faculty," and which is supposed to be "the sensation and the memory of the positions in space of the median plane of the body"? Thus described, does not this faculty seem rather too closely akin to the *virtus dormitiva* of Molière's opium? To express it more simply, is it memory, or an unconscious visual or olfactory orientation? Is it perhaps something quite different, of which we have as yet no idea, and which those who possess it are incapable of explaining? Let us not venture into this labyrinth, for we should not readily find our way out of it, in spite of our

semicircular canals, but let us rather content ourselves with summing up what we may learn of the matter by observing the ant.

It is admitted that the orientation of the bee and the wasp is almost exclusively visual. This cannot be the case with the ant, which, in general, is almost blind, or at best can see only an inch or two. From a large number of experiments made by Sir John Lubbock in the close proximity of the nest it appears that the ants make much less use of their eyes than we should do under similar circumstances, but that nevertheless they are, to a certain extent, guided by sight. On the other hand, Bonnet, J. H. Fabre, Brun and Cornetz, by interrupting, sweeping, flooding and deodorizing their tracks, have shown that the olfactory sense plays but a secondary part in the maintenance of direction, and that after a little groping they are perfectly well able to follow what has been called "the odoriferous rail."

The latest experiments of Cornetz, the per-

spicacious Algerian observer, show that an ant taken at her nest, but, of course, *at a moment when she has not just returned from a journey*, and removed to some little distance, does nothing but turn around and around, and cannot find her way back to her nest. On the other hand, some distance from her nest, offer an ant some food on a tray, carry this tray where you will, into the sun or into the shade, and while the worker is filling her crop turn it gently round, reversing it north and south, for example: the insect does not lose her bearings, and returns directly to the nest. She therefore possesses and retains a sense of the right direction, and is not in the least confused by the fact that she has, unawares, been turned head to tail. This experiment and others like it almost invariably fail to bewilder her; and from them Cornetz deduces the following formula: "The ability to return is a function of the outward journey covered in the course of an exploration, and not the function of visual, tactile or olfactory memories."

Nevertheless, it is possible to lead her astray by presenting her, on her homeward journey, which follows, for example, a northerly direction, with a veritable bait, and carrying her, while she is feeding, past her nest, after turning her halfway round. She will turn round again and proceed in a northerly direction as before, without realizing that she has passed her nest—that she has turned her back on it and is hopelessly astray. But what human intelligence would be proof against diabolical tricks of this kind?

VII

To what can we attribute this faculty? How can we explain it? Here our difficulties begin; or rather, they recur. I shall not expound in detail the various theories which attempt to explain it; they are not particularly lucid, and they all end in a more or less veiled confession of ignorance. These theories evoke a mnemonic element which recalls the nest, or an image of the point of departure, thanks to which the insect replaces

the axis of its body until the nest is behind it; which is merely transposing the problem. They speak of the "homing instinct," which is a purely verbal explanation; of a compensated progress, which allows for divergences by referring them to an axis; but they do not explain this sense of an axis. They speak of tropism and phototropism, and of the sun as a visual point of reference, even in the shade or in darkness, for there are radiations which pass through the most opaque substances; and in this connection we must not forget that the ant is sensitive to ultra-violet rays.

"Everything happens," says Rabaud, on the other hand, "as though the animal, having set out in a given direction, were by that fact polarized." And Cornetz concludes that there must be some unknown factor of reference which continues to act after the ant has been moved or turned round, determining the resumption of progress parallel to the original course. But even this is to answer the question by another ques-

tion. Cornetz then develops the "topochemism" of Forel, which is supposed to be not merely olfactive, but active at a distance, and which would enable the ant to perceive a sort of olfactive panorama, and even a panorama in relief or perspective, enabling her to perceive the odor of an object, *in extenso*, as a flat or a pointed odor—in a word, if I understand M. Forel, an odor in three and perhaps in four dimensions. The ant would thus be conscious of "a topography of a chemical nature, with odors as an element of specific energy." She would be aware at a distance of odorous emanations which would prolong in the air their physical and spatial geography, but in a less definite fashion. "Thus," adds E. L. Bouvier, "provided with this topochemical sense, which enables them to become cognizant of forms and the relations of forms, they are capable of distinguishing, by their odoriferous fields, the differences presented by the outward and homeward course of a journey, by the right-hand and the left-hand

side of the track, and consequently, the direction to be followed. Not without some difficulty, Forel's workers succeeded in finding their way even when their eyes had been covered with opaque varnish; when their antennæ were amputated they were quite incapable of doing so. Scent, therefore, rather than sight plays an essential part in this phenomenon."

VIII

We must not forget—for we must overlook nothing—the possibility of an internal orientation; and this brings us back to the semicircular canals, which do not, it seems, exist in the tiny head of the ant, but which may be replaced by the antennæ, by Cornetz's "sense of angles" and Bonnier's "sense of attitudes," which enable the ant to correct deviations and to follow a path parallel to her original course. But what is the nature of this sense? We always return to the same problem, since the hypotheses hazarded always return upon themselves. For the rest,

Cornetz has found that ants are able to retain their knowledge of direction even when the succession of angular sensations is interrupted; and this was proved, moreover, by Lubbock's experiment.

We must not forget Piéron's "muscular memory; that is, the memory of the various movements effected in order to travel from one point to another; a reversible memory, enabling the ant to return to the point from which it started." Brun, reviewing Piéron's experiment, concludes that "the ant behaves as though she possessed a compass, on which she could read the absolute direction of her journey, and a pedometer, which constantly indicated, at any point of the journey, the distance still to be covered."

I would rather believe that she is herself the compass or the needle which denotes the direction of the nest; a compass or needle which in the nest would be inert and demagnetized, and would recover its paramagnetic or pseudomag-

netic properties only when it was resensitized or recharged by the outward journey; for we cannot be sure that there are not, in a world so completely unlike our own, forces analogous to our electricity or magnetism, whose existence we do not as yet suspect.

All this, of course, seems very complicated, but in all probability it is very simple for the ant, the similarity of whose organs to our own is more apparent than actual.

And thus the problem stands. We are still completely at sea; and we realize what strange mysteries lie hidden in the most infinitesimal lives.

PASTORAL ANTS

PASTORAL ANTS

I

WE may without rashness assert that primitive man, who may have lived many thousands or hundreds of thousands of years before the prehistoric man whose relics we find in certain caves, had no domestic animals. He lived only on roots, nuts, berries, shellfish, and the product of his hunting. Very gradually, after thousands of years, as the result of innumerable confused experiments, and much obtuse and obscure reflection, he succeeded in attracting, taming, sheltering, tending and breeding a certain number of inoffensive animals, who provided him with their milk, their wool or hides, and their flesh, and that of their young. Thenceforward his existence became a little less precarious, a little less harassing. There was

now a barrier, a sort of protective zone between life and the intolerable and daily menace of death. The pastoral age succeeded to the distressful age of hunting and fishing and unremitting hunger.

We find an analogous advance in the evolution of certain species of ant. Are they more intelligent than the majority of their fellows, who have remained warriors, hunters, brigands, marauders and reapers, and who depend for their livelihood on the uncertain booty of the day? Or do they not rather owe their progress to the benevolent accident which turned their attention to a fact which others had not realized? At what period did the first idea emerge? As to this, we know nothing. But we are just as ignorant of our own history. We find many examples of these pastoral races, and notably of almost all our *Lasius*, as well as their aphides, in fossil amber. We should therefore have to go back to a period very much earlier than the Tertiary: that is to say, thousands or millions of

years before our own advent. But all documents are lacking.

It is highly probable that, as so often happens in our own life, the discovery arose one day from a fortuitous circumstance. Roving at hazard, in search of the daily ration of honey, an ant came upon a tribe of plant-lice assembled on the tip of a tender green shoot. A pleasant saccharine odor reached her antennæ, while her little legs were agreeably enmeshed in a sort of delicious dew. The discovery was miraculous, and seemed to be inexhaustible. Immediately she proceeded to fill to the bursting point her collective pouch, her omnibus stomach, her municipal flagon, and hurried back to the nest, where, amidst the exaltations and convulsions of the ritual regurgitation, the magnificent find was echoed abroad, the discovery that promised an era of inexhaustible abundance and bliss. After an excited antennal dialogue the whole community set out, in long files, for the miraculous wells of plenty. A new age had commenced;

they felt that they were no longer alone in a world in which all things were unfriendly.

II

The example was not wasted; nevertheless, the majority of the ants did not follow it. Was this a matter of race, or intelligence, or routine, or habit, or alimentary preferences? Who shall say? Experiments have yet to be made in respect of this important point; they may one day reveal an interesting corner of myrmecæan psychology, and perhaps even the ideas and intentions of the *Anima Mundi*. What would happen if (as is quite possible) one were to induce a pastoral race of ants to adopt, as slaves or partners or allies, a tribe which had never lived the pastoral life? Very probably the latter would imitate the former, and share their labors. But what would happen if after a time a portion of the recently initiated tribe were isolated from their tutors? Would they adopt, as human beings would do, the novel methods whose advan-

tages they had learned? If one of their fertilized females founded a new colony, would her offspring go in search of melliferous plant-lice? Analogous experiments might be made with the mushroom-growers and weavers, of whom I shall presently speak. Would the adoptive daughters, slaves, or allies of the former proceed to cultivate mushrooms, and would the allies of the weavers, left to themselves, conceive the idea of utilizing on their own account the wonderful and providential shuttle which had been wielded in their presence? We see, and we shall see again, that despite all that has been accomplished much remains to be done, and as yet we can see no bounds to the fields of investigation.

III

In any case, we know already that not all the ants are content to exploit this great accidental discovery in a simple and mechanical fashion. Some species have gradually developed and perfected their methods of exploitation; we may

say indeed that man himself could have done no better. To begin with, they acquired the conviction that the herds grazing in the neighborhood of their nest were incontestably their property. They learned to assemble and pack and tend their plant-lice, and to milk them regularly, or rather to solicit and multiply their saccharine evacuations by suitable caresses; for it must here be confessed that they do not draw the "milk" from the so-called "teats," but—a less idyllic matter—provoke and facilitate an anal secretion. They select their herds, and have succeeded in obtaining, from the same aphis, twenty to forty drops of secretion per hour. Careful, busy, diligent, they pass continually to and fro between their nest and the herds of aphides or coccidæ, as a grazier goes to and fro between his farmhouse and his pastures. They surround their flocks with meticulous precautions. The less civilized content themselves with mounting guard over them, threatening with their shears marauders prospecting for honey-

dew; the struggle for existence and the conquest of natural resources is for them as strenuous a business as it is with us, as implacable, and far more immemorial. Others, more practical—our *Lasius niger*, for example—have hit upon the notion of amputating the wings of the plant-lice, in order to prevent their escape, and to facilitate transport; or they fence them in, or build covered paths for them, or prepare shelters in which they can take refuge when it rains. Others, like the *Cremastogaster pilosa* of America, make cages of papier-mâché to protect them from the larvæ of the cochineal insect or the ladybird, which devour them greedily. There are even species, more prudent still, which stable their cattle in their nests, and feed them there. The *Lasius flavus umbratus* do even better. Rarely going abroad, and shunning the daylight no less than the termites, they have discovered plant-lice which have the same tastes, and which live exclusively on the roots of certain plants or trees. When necessary they go in

search of them, driving tunnels through the soil, and when they have found them they remove them to their subterranean cattle-sheds at the bottom of the nest, and so the whole community lives very prosperously in the darkness.

And here is something even more surprising: Pierre Huber, whose observations have since been confirmed by Mordnilko and Webster, was the first to remark that *Lasius flavus* collects the eggs and rears the young of its aphides, and that in case of panic it endeavors to save them as well as its own offspring.

IV

The aphides and the coccidæ are not the only insects herded by the ants, for they have domesticated also certain small jumping insects. I will not weary the reader by enumerating them, but I must not omit to mention the manner in which various species of ants exploit certain caterpillars which secrete a saccharine fluid, and especially the *Lycenidæ*, the larvæ of our Argus

butterfly. They straddle the caterpillar, which for them represents a gigantic horse, and while the apocalyptic worm carelessly gorges itself with food, they caress with their antennæ the last segment of its abdomen, which emits the honey-dew of which they are so fond. Every ant—or it may be every squadron of ants—will obstinately defend her steed against the parasites that attempt to approach it, and even against man himself. In India, before the rains, according to the observations of Mrs. Willy, these ants go forth in search of certain caterpillars, which will eventually become beautiful blue butterflies, and carry them off by the hundreds, sheltering them in their subterranean galleries, where they watch over their long sleep as chrysalises, until the emergence of the perfect insects, when they help them to escape from their sheath as though they understood the mysteries of metamorphosis.

Many myrmecologists insist that these things are due merely to chance, to lucky coincidences

which have gradually been developed into routine. A worker, exploring in search of booty, comes upon a plant-louse; rashly and inquisitively, attracted by its sweetish odor, she feels it, tastes it, finds it good, and hits upon the secret of its mechanical reaction. She returns, and others follow her and imitate her; the custom spreads, and being established it becomes first a habit, and then an instinct. The theory is quite defensible, for where all is unknown we may hazard any explanation. But what human invention would hold out against such interpretations?

THE MUSHROOM-GROWERS

THE MUSHROOM-GROWERS

I

HERE the ants approach the methods of the termites. We know that the termites live only on cellulose, but cannot digest it. They therefore entrust the preliminary assimilation either to the flagellated protozoa of which they harbor millions in their intestines, or to tiny fungi, whose spores they sow on a carefully prepared compost. Thus, in the heart of their nest, they grow enormous crops of cryptogams, as carefully selected as those raised by the cultivators of the common mushroom in the old quarries on the outskirts of Paris.

Did the ants, who are geologically posterior to the termites, borrow the idea from them? It is quite possible that having taken by surprise an enfeebled or ill-defended termitary, they

found their mushroom-gardens in full growth. If they did not originate the idea, they at any rate understood its advantages. And is it not an added merit that the ant has no need of protozoa or fungi to assimilate her food? She was not confronted by one of those vital necessities which stimulate the intellectual faculties to their highest pitch, and force them to work some despairing miracle; for her the culture of fungi was a simple and practical means of providing abundant, wholesome and always fresh victuals in the very heart of the subterranean city.

Let it be noted, by the way, that the fungi-cultural ants do not cultivate the same cryptogams as the termites. The latter are acquainted only with an Agaric and a Xylara, which are not found in the formicary. We may be certain, therefore, that the ants did not sow their beds with spores taken from a termitary; and hence it is very probable that both the ants and the termites derived the idea from a fortunate ac-

cident, by which they were intelligent enough to profit most abundantly.

II

There are no fungicultural ants in Europe. They are found only in tropical America. Until the recent researches of Belt, Möller, Forel and Sampaio, and the revelations of Jacob Huber and Goeldi, it was not known that they cultivated mushrooms. McCook, who was the first to observe them, believed that they confined their activities to gathering and cutting the leaves of certain trees, and this belief was generally accepted. Thus, in treatises which date back more than forty years, and notably in the excellent work of Ernest André, they are known as Leaf-cutting Ants, Visiting Ants, Manioc Ants, Parasol Ants, Saüba, etc.

They belong to the powerful tribe of the Attini: large ants with long legs, remarkably polymorphic, as voracious as they are ingenious.

They have evolved apart from the rest of their kind, and are probably the descendants of certain of our European ants who were already living in what was to become America before a great cataclysm sundered the New World from the Old. They take no other food besides the fungi which they cultivate. Their lives are thus closely bound up with their subterranean gardens; and on the other hand, their fungi, the *Rhozites gongylophora*, or at all events their "kohlrabis," a sort of tiny capsule which forms on the ends of the filaments of mycelium, do not grow without their intervention. When the founder of a future community sets forth on her nuptial flight, she carries with her a little of her native soil, in the form of a tiny pellet of mycelium, which she sows in the chamber in which, as we shall presently see, she will cultivate cryptogams, nourishing them at first with her own substance, that is to say, with all the nourishment contained in her abdomen and in the powerful muscles (which are gradually ab-

sorbed) of the wings which she tears off on falling to the ground after her hymeneal flight.

III

In a nest of *Attæ*, *Attini* or *Attineæ* three types of worker are found: the giants, who are sometimes more than two-thirds of an inch in length, do not go abroad, but defend the entrances to the nest; the medium-sized workers, who cut, dissect, and store the leaves; and the small workers, who do not leave the nest, but sow the spores and the supply of compost of which they make their mushroom-beds.

The preparation of this compost demands infinite care. The workers triturate it, knead it, heap it up, and fertilize it with their excrement, and with starchy substances and manioc seeds, which activate its fermentation. Have you ever cultivated the common mushroom? It is not so easy as you would imagine, or as the handbooks on the subject would have you believe. These manuals pretend that it is enough to make a bed

of horse-dung at the bottom of a drawer, and to spread it with mycelium, and in a few days' time the little white heads pop up all over the bed, like so many gnomes that were only waiting for the magician's word. As a matter of fact, five or six times out of ten nothing of the kind occurs; the manure is not ripe, it is too hot or too cold, too dry or too moist, the filaments are too young or too old, or secondary fermentations intervene, or a thunderstorm sterilizes the spores, and so on. In short, a certain experience is necessary, which is acquired only by practice; that is, by observation, reflection, inquiry into the causes of failure, the progressive correction of these causes, the study of the temperature, of the hygrometric conditions, the light, the ventilation, and what not.

Do not imagine that as much and perhaps more care is not necessary in the cultivation of the tiny cryptogams of the *Attini*, which are far more fragile, far more evanescent than our large and robust agarics.

To a German myrmecologist, Alfred Möller, we owe some curious observations of the manner in which the *Acromyrmex*, another fungicultural ant of southern Brazil, prepares her gardens. Each species, by the way, has its own method of procedure, its own technical tricks; which proves once more that we have here something more than purely instinctive or mechanical actions.

On reaching the nest the *Acromyrmex*, by means of her mandibles, which she uses like scissors, begins by cutting the leaf into fragments about the size of her head. She then scrapes and peels and rubs and softens these fragments, and works them into a pellet, and maneuvering this with her head and legs, she pushes it into its proper place. In a few hours' time the mycelium—that is, the white filaments of the mushroom-bed—begins to make its appearance, and by the evening the pellets put in place that morning are covered with these filaments.

But the ant obtains her nourishment not from the mycelium, the fine white filaments, nor even from the conidia or spores, but from what are known as the "kohlrabis": tiny globular masses, which are a special, artificial and exclusive product of myrmecæan fungiculture. In order to obtain this product it is essential to prevent the excessive proliferation of the mycelium; and to this task the smallest of the workers devote themselves, constantly pruning the growth. Sometimes, when their numbers are insufficient, they are oustripped; they can no longer cope with the invader, and in order to escape asphyxiation they are forced to retreat before the advancing forest, carrying their larvæ with them, in order to save them from the filamentous plague; after which the "kohlrabis" are crushed and disappear, and the specialized nursery becomes a natural, uncultivated mushroom-bed, like a deserted garden in which the weeds have got the upper hand, and have destroyed the garden flowers.

You will realize that the cultivation of these fungi is a complicated business, requiring as much skill and experience as the cultivation of the giant chrysanthemums or the rare orchids which are the pride of our great horticulturalists. But why—simply because insects are in question—must we not speak of invention, experience, understanding, reasoning, intelligence?

IV

These things, it may be objected, are explained by tradition, by routine, whose fixation becomes instinct. In this case, as in many others, I do not think this explanation can be accepted. If there is routine or tradition, it must have begun one day with an intelligent action; it must have been formed gradually, like our own. The use of manure, for example, the knowledge that it stimulates vegetation, is not, I imagine, innate in the ant, any more than it is in ourselves. It will be suggested that the ants deposit their excrement here, there, and everywhere,

and that their cultures profit by chance. But this is quite untrue. The fungicultural ants, like other ants, are most careful to carry all excretions, all detritus, all useless rubbish out of the nest. Nothing could be cleaner, tidier, and more carefully kept than their subterranean cities. What they do in this case they do with full intention. Photographs taken by Dr. Jacob Huber clearly show an *Atta*, who takes a fragment of mycelium between her fore feet, and presses it against the tip of her abdomen, which being previously curved forward, emits a brownish drop, which is immediately absorbed by the white mycelium. Huber saw her repeat this operation once or twice hourly.

The truth is—and the same might be said of many of the ant's actions—the truth is that we are reluctant to admit that there are in the world other beings whose intelligence or moral qualities give them as valid a claim as our own to a certain spiritual importance, and suggest that they may be destined to play some exceptional

part in the world, to achieve some sort of immortality, to nourish vague and magnificent hopes. That they should share with us a privilege which we believe to be unique shatters our immemorial illusions, humiliates and discourages us. We see that they are born, live, perform their humble duties, and disappear, in their hundreds of milliards, without leaving a trace. No one troubles about them, and they have never attained any other goal than death. We are not willing to admit that it may be the same with us. We would rather believe that all is stupid, instinctive, automatic, irresponsible. One day we shall learn, as all the creatures that share this earth with us have already learned, to content ourselves with life. This will be the ultimate ideal, enlarged by all those which it will have absorbed; and we shall find, perhaps, when we know how to live it, that life is enough; and that at all events this ideal is as great as the majority of all other ideals, and less disappointing.

V

The *Attini* often live in enormous confederate nests. In that which Forel studied in Colombia the principal portion was sixteen to twenty feet in diameter and over three feet in height. It was flanked by tumuli of smaller dimensions, with accessory dwellings situated at a distance of two or three hundred yards from the parent nest. The ravages committed by these powerful ants are comparable to those of the termites, and only the vigor and luxuriance of the tropical vegetation could possibly survive their devastations. The tree which they attack is doomed; all the leaves, sawn off at the petiole, fall to the ground, where they are received by other ants, who cut them up on the spot into morsels of portable dimensions, and then, moving off in the shade of these scraps of foliage (whence their name of Parasol Ants), they return in long files to their nest. In less than an hour all is finished; and from the devastated

tree, which is now a bare skeleton, they pass on to its neighbor, which suffers the same fate.

Once in the nest, the leaves are again cut up into very small fragments, and with these, when they have undergone further repeated triturations, the beds of the subterranean gardens are made.

These gardens, could one enlarge them to the human scale, would seem like scenes from fairy-land. Imagine a submarine or lunar landscape, which under the microscope (as one of my Californian friends once showed me) reveals pale bluish depths in which a vermiform and globular vegetation grows luxuriously; here are sheaves and thickets of white, immobile, tentacular flames, ethereal flakes and fluid efflorescences, sponges of downy snow, and a swarming, menacing tangle of bloodless larvæ, which seem to be invading everything, yet do not move from their places; livid networks, cloudy tresses, impearled with translucid eggs, whose number increases from hour to hour.

I must not forget to mention a curious *Attinea*, a native of the Argentine: *Atta Vollenweideri*, which has recently been studied by Dr. Carlos Bruch of Buenos Aires. It cultivates its mushrooms, not in the depths of its subterranean nests, but on their surface, in the open air. The enormous cryptogam which forms its exclusive nourishment, *Locellina Mazzuchi*, whose cap attains a diameter of twelve to sixteen inches, and may weigh as much as six or seven pounds, is never found elsewhere than on its nests; just as the *Poroniopsis Bruchi*, another fungus of equal dimensions, grows only on the nests of another *Atta*, *Acromyrmex Heyeri*, which are never found without it. Here, as in many other connections, it would be difficult to invoke chance and deny the intervention of a conscious and intelligent will.

VI

The founding of a fungicultural community is as difficult, as hazardous and heroic, as the

founding of one of our European formicaries, and it is complicated by the necessity of cultivating the indispensable mushrooms. Jacob Huber and Professor Goeldi have continued and completed Möller's study of these communities. Their observations relate to *Atta sexdens*.

As soon as she is installed in her underground lodge, the *Atta* in question disgorges her pellet of filament and proceeds to fertilize it in the manner already described. In a few days' time the pellet comes to life, emitting hyphæ—that is to say, fine white hairs—in all directions. The mushroom-bed, once started, spreads rapidly, and the first eggs are laid on it. From this moment, until the formation and appearance of the first workers, the mother, the larvæ, the nymphs, the patches of fungi, and even the eggs themselves, have no other nourishment than the eggs. It is a case of complete and exclusive and unavoidable ovivorism. Before any of the "kohlrabis" or globular masses of mycelium cultivated by the first workers are con-

sumed it is calculated that the mother lays two eggs hourly, and in all about two thousand, of which eighteen hundred are devoted to feeding the nascent colony. During this period the mother has nothing to eat but her own eggs, for neither she, nor her larvæ, nor her nymphs touch the "kohlrabis" or the mycelium from which they are developed. What, then, is the secret of this making of something out of nothing—of this creation in the true sense of the word? Where does the ant obtain the substance of these two thousand eggs, of which she herself consumes no more than three or four hundred, and which represent the weight of her body? What is the secret of this perpetual increase *in vacuo*, no less extraordinary than perpetual motion would be? Is there something unknown to us outside her, which supports and multiplies her life? Such phenomena are found only in the incredible world of the insects. What is the explanation of this uncontested mystery? Hitherto no one has discovered it.

AGRICULTURAL ANTS

AGRICULTURAL ANTS

I

HAVING described the fungicultural ants of the subsoil, I must not forget the makers of aerial gardens. These are small ants of five or six different species, whose extravagant names it is needless to enumerate. They are found, for the most part, on the banks of the Amazon, and they build their nests, which are round as balls, in the crotch of two or three branches. These nests would not be especially remarkable, but for the fact that the ants sow in them the seeds of epiphytes, which, as you may know, are small plants which appear to be parasitic, though they are not actually so, and belong to a family of which many of the orchids are members. These nests, we learn from Ule, who has made a special study of

them, are like flowering sponges. He insists that it is quite impossible that the seeds should have been carried to the nests by the wind, or by birds, for these gardens are frequently made in areas where no epiphytes are found; moreover, the species of epiphyte grown in these nests refuse to flourish except in a soil prepared by the *Atta*. Another proof: when these ants are given a berry plucked from their favorite plant, they suck the juice, and carefully plant the kernel in their nest.

They cultivate these plants, not for the sake of their flowers or foliage, but in order to consolidate their nest by means of the fibrous tangle of the rootlets of these pseudoparasites. Thanks to these, the balls of humus which serve them as lodging acquire a cohesion and solidity so great that they are able to resist the most violent tropical rains, no less than the scorching rays of the tropical sun. To tell the truth, however, the habits of these ants are still

under discussion, and await further observation.

II

But the true agricultural ant is the insect wrongly known as the Sower Ant, which is really a Weeding Ant: the *Pogonomyrmex molefaciens* of Texas and the *Pogonomyrmex barbatus* of Mexico. I remember admiring a nest of *Pogonomyrmex* when walking one afternoon in the neighborhood of Houston, Texas, where I broke my journey from New Orleans to Los Angeles. It is as well not to disturb this ant, for its sting injects a poison of whose nature little is known as yet, except that it is not formic acid, and that the effect is extremely painful.

In the grassy plains, which are invaded by a dense and vigorous vegetation, they laboriously clear a circular area round their nest, from which beaten paths lead off into the scrub; and on this denuded area they permit nothing

to grow except a single species of grass, *Arista oligantha*, commonly known as ant-rice or needle-grass.

Lincecum, who was the first to observe these ants, declares that they cut this grass, but McCook, whose observations are more recent, states that they content themselves with exterminating all the other plants which grew amidst their favorite cereal by means of incessant weeding. They live the lives of true pioneers, being gardeners and agriculturalists, and above all weedcutters, for to these tiny insects the tall subtropical weeds are like gigantic trees, which they saw through at the base until they fall of their own weight.

McCook's opinion is corroborated by Wheeler, who, during a sojourn of four years in Texas, had the opportunity of observing these ants at leisure, and of detecting the cause of Lincecum's mistake. The *Molefaciens* do not seem to take the precautions which are taken by the Harvester Ants of Algeria or the south of

France with a view to preventing, or at all events retarding, the germination of the grain which they store in their granaries. When, after several days of rain, the seeds begin to germinate, and threaten to invade the nest, they hastily rid themselves of those that are no longer fit for consumption, and carry them some distance from the nest, depositing them on their refuse-heaps, where they take root, giving rise to the "rice-fields" which so puzzled the first explorers.

III

Besides these agricultural or horticultural ants, there are others which do not cultivate their grain, but only harvest it and store it in granaries. The ants of the colder countries do not, as is commonly believed, make provision for the winter; they spend that season in the depths of their nests, sinking into a torpor from which they do not awake until the spring: that is, until there is food once more to be obtained outside the nest. But other species, which in-

habit warmer regions, where the winter, though unfruitful, is less rigorous, and does not make them torpid, take precautions, and make provision for the future. Of these ants one of the best known and most frequently studied is the *Messer barbarus*, which is found in the south of France, and abounds in Algeria, where it is greatly dreaded. It has been studied by J. T. Moggridge, Escherich, Arthur Brauns and Cornetz. This large ant stores in her underground granaries the seeds of various plants, picking them up off the ground, or even gathering them from their stems or peduncles, either twisting the latter, or shearing or sawing them through with the toothed secateur of her mandibles. A strict watch is kept at the entrances of the nest; the apprentices or novices who naïvely bring tiny pebbles, or scraps of broken crockery, or inedible seeds, are soundly snubbed, and told to take their useless burdens elsewhere. I need not describe the scenes enacted at the entrances to the galleries when an ant tries to carry in a

seed in the husk, which is too large to pass, or the tip of an ear, which keeps on sticking in the passage. Such spectacles may readily be observed in the summer, between Saint-Raphaël and Mentone, and for those who have enough imagination to transpose them to the human scale they are not the least entertaining to be seen on the Côte d'Azur.

These seeds are heaped up, and sometimes methodically classified, in granaries which are more carefully cemented than the rest of the formicary, but are nevertheless rather damp during the rainy season. How do the Harvesting Ants prevent them from germinating? This is a problem which the myrmecologists have not as yet completely solved. Some say that the ants carry the seeds, when necessary, into a sort of drying-chamber situated near the surface of the nest; others insist that they subject them to a special preparation, which inhibits, without destroying, their power of germination: for they develop normally when sown outside the nest.

Others, again, believe that they simply nibble off the radicles as they make their appearance, and even that it is this sort of malting process that renders them assimilable. In any case, the ants never eat the seeds in their dry state, but break them up and triturate them, making them into a paste or very thick broth. Specialized soldiers, with large heads and enormous mandibles, are generally employed as bread-makers. And in this connection, since the worst must be told with the best, I must mention a Harvesting Ant of the *Pheidole* family, whose revolting ingratitude and cruelty, habitual in the world of the bees and termites, is exceptional in that of the ants. When the summer is over, and these unfortunate pastry-cooks are no longer of any use, the secret council of the community sentences them to be decapitated and thrown out of the nest; and when the spring returns the fecundated females are ordered to create their successors.

IV

The Weaver Ants

Properly speaking, they are arboreal rather than agricultural. They occupy a unique position. Here we have the very summit of art and industry. The Weaver Ants, *Œcophyllas* and *Polyrhachis*, discovered, or rather made fully known to us less than thirty years ago, inhabit the tropical regions of Asia, Africa and Australia. It has recently been demonstrated that the *Camponotus senex* of Brazil weaves its nest in the same fashion. The Weaver Ants enjoy some popular regard in Indo-China, where the natives respect them and protect them, for they defend the plantations against the attacks of various parasites. They have been studied by Bugnion, Doflein, Dodd, Karl Friedrichs, Goeldi and others.

In order to build their nest, they begin by fixing their choice on two or three leaves which they wish to join together. Their *modus oper-*

andi has been fully described by Dodd. Taking up their position in a row on the edge of one of these leaves, to the number of a hundred if necessary, and holding firmly on to it, they seize the adjacent leaf with their mandibles. If they cannot reach it directly they make a number of living chains or bridges; one ant seizes her neighbor by the petiole, between the metathorax and the abdomen, until the mandibles of the ant so held are able to seize the other leaf and draw it nearer. When the edges of the leaves are touching, or are brought within what is considered a convenient and suitable distance from one another, they have still to be held in place. Now the weavers play their part. Each of them carries between her mandibles a larva which was preparing to weave its cocoon, and which has been dragged away from its personal preoccupations to perform a work of public utility. This is why the larvæ and nymphs of the Weaver Ants are always naked, all the available silk being requisitioned for the construc-

tion of the nest. By means of the still viscous thread secreted by her living shuttle, the weaver, moving the larva to and fro, joins and anchors the edges of the two leaves. The other weavers, with their larvæ between their mandibles, perform the same operation along the whole length of the leaf; and the work is continued until the nest is completed, when it has the form of a huge cocoon, divided into an infinite number of chambers with silken walls and pillars.

V

Here, then, we have the first example, in the animal world, of the employment of a tool. We shall find no other example among the insects, nor even among the mammals, which occupy the highest positions in the hierarchy of living creatures. It is true that an ape has sometimes been seen to make use of a stick in order to rake in a banana or a nut which was not within reach of his hand; but the action seems so precarious and uncertain, and inspired by such

incoherent and fortuitous impulses, that it cannot be compared with the deliberate and methodical use of the distaff and shuttle. In no other domain have the ants approached so nearly to human intelligence. They have really crossed a barrier which seemed almost as inviolable as that of the use of fire.

We are not surprised when the most intelligent of our domestic animals approach every day within a hand's-breadth of an idea without perceiving it. But how can we be sure that we ourselves do not pass by many ideas which to other minds must appear as simple and elementary as the idea of the tool, but which we shall, perhaps, never perceive, although, as the children say, we are constantly "growing warm"?

Will the ants go farther still? We may study their evolution from the palæontological eras to the present day, but we cannot answer this question. Yet it is not impossible that in this direction the future holds, if not precisely dangers, yet shadows with which we shall have to cope.

At all events, their progress will be so slow that when they become a menace we shall no longer exist; for everything seems to foretell that man, the last comer to this earth, will be the first to leave it—going we know not whither.

VI

Living Reservoirs

The honey-ants, bottle-ants, bonbon-ants or reservoir ants of which I have already said something in a former chapter have been given, by the entomologists, the less vulgar, less picturesque, less easily pronounced and less readily remembered name of *Myrmecocystus melliger.*

We owe to McCook almost all that we know about these ants. Like the mushroom-growers, they love the hot regions of the earth, although nature, in other climes, has tried her hand at experimental forms or imitations of the type; notably in dry countries, where they are almost indispensable to insects which have not yet

learned how to make barrels, jars or bottles, and yet wish to keep a reserve of liquid nourishment.

McCook studied these ants in the *Hortus Deorum*, the Garden of the Gods of Colorado. They live exclusively on the drops of honey-dew exuded by the galls of a certain oak, the *Quercus undulata*, and they gorge themselves until they have trebled or quadrupled the volume of their abdomen. Those which have distended their bodies to five or six times the normal volume are promoted to the rank of reservoirs; they are finally gorged in the nest until they are eight times the normal weight; after which they cling with their fore-legs to the roof of one of the ten or twenty honey-cellars excavated in the red sandstone, and remain hanging there until their death, and even longer, for sometimes their claws do not relax their hold until two or three days after their decease. We can see the inconveniences, but we are inclined to ask what are the advantages of

this onerous promotion. Are they to be found in the delights of regurgitation, in a phenomenal stupidity, in the satisfaction of a boundless vanity, or in the joys of absolute sacrifice? What in our world would seem improbable is not necessarily so in that of the ants.

The ordinary insect is a fifth of an inch or more in length; swollen to bursting, she becomes translucid, and attains the dimensions of a large currant or small grape, and this grape contains a honey which is, it appears, delicious, and is greatly sought after by the inhabitants of Colorado.

The formicary explored by McCook, with its superimposed cellars and galleries, occupied a space of about ten feet in length, twenty inches in width, and forty inches in depth; it was entirely excavated in a red sandstone, moderately friable, but very much harder than vegetable humus. It contained ten cellars or honey-chambers, each containing some thirty living bottles.

If one of these balloon-like insects becomes

detached from the roof and falls heavily to the floor and bursts, the slender ants make haste to consume the sugary spoil. If she remains intact she cannot raise herself from the ground, nor climb back to her post on the roof of the cellar. None of the other ants will touch her, and none will come to her assistance, and waving her legs despairingly in the air, she finally perishes where she lies, lingering sometimes for several months. Then the slender ants divide the thorax from the abdomen, and without profaning it with their mandibles they roll the latter out of the nest, to the place which serves them for cemetery, and there they leave it.

This, in a few words, is as much as we know of their habits. I do not think the habits of the Selenites, or the inhabitants of the planets of Betelgeuse, would seem more surprising and inexplicable.

Although here, as in so many other instances, we find ourselves out of our depths, we need not therefore be dejected. We shall never be

more than the playthings of an hour, and we cannot hope to conceive of the absolute. What we have acquired we have acquired, and we have thousands, indeed millions of years to discover the rest. After all, there are many problems more urgent than this, though all things are interrelated, and the least indiscreetable reply to the least of questions, whether this reply came from Antares, from a "white dwarf," or from the formicary, would be of value in respect of all the things that concern us most nearly.

VII

To supplement the chapters devoted to the Weaver Ants and Reservoir Ants, we will briefly review a certain number of minor industries which have not hitherto been mentioned. We know that the organization of labor in the formicary is much more methodical and deliberate than the disorderly agitation which we commonly observe at the surface of the nest would lead us to believe; an agitation,

by the way, which in nine cases out of ten may be imputed to our own presence, menacing as a cataclysm, to our untimely intervention, our inconsiderate gestures. In the darkness of the underground galleries each worker has her task, each knows exactly what she must do, and does it with due care. No sooner has she emerged from her shell than the ant who was but lately a nymph, moving still uncertainly on legs that have not yet completely hardened, busies herself about the eggs, larvæ and pupæ, which she feeds, turns over, and moves from place to place, brushing, combing and cleaning them incessantly. She will not venture from the nest until her limbs and her chitinous cuirass are sufficiently hard. She will then become explorer, scout, shepherd, purveyor, gardener, mushroom-grower, harvester, navvy, mason, carpenter, honey-jar, warrior, nurse, housekeeper, etc., according to her race, her vocation, her aptitude, or the orders of the central intelligence.

But sometimes her specialization is so emphatic from her very birth that it modifies the structure of her body. These modifications are less general, but often are as profound and radical as in the termites. Certain workers are provided by predestination with special tools, accordingly as they have to saw, cut, dissect, bore, or triturate. Those who are to be soldiers acquire mandibles twice or thrice the size of the normal mandibles. Others possess spring mandibles which enable them to jump like fleas, thereby escaping from their disconcerted adversary. A little-known inhabitant of the virgin forests of Brazil, the mysterious *Gigantiops destructor*, an ant with large eyes, leaps from branch to branch, and an Indian ant, *Harpegnatus cruentatus*, can jump twenty inches by means of her mandibles.

There are ants covered with spines, and ants provided with sheaths which protect their fragile antennæ. Inhabitants of the desert, who have to spend much of their lives in carrying

grains of sand, are provided with enormous heads, spade- or spoon- or dome-shaped. We have only to assemble on a sheet of paper a few faces belonging to different species of workers or soldiers, and we have a collection of masks such as no carnival mask-maker of Nice or Venice has ever imagined.

VIII

One of the most curious of these masks is that worn by the soldier who is also a door-keeper. Or, to be precise, she is not a door-keeper, but her head, monstrously specialized, is itself the door, fitting exactly, like a stopper, into the entrance to the nest. If this nest is installed in a stem of bamboo, for example, the head of the doorkeeper assumes the appearance and color of the stem; if it is in the trunk of an old pear-tree it is camouflaged like the bark of the pear-tree. We find a whole series of intermediary forms, from the full doorkeeper

or living door, to the semi-doorkeeper, the deputy doorkeeper, the candidate, the amateur, etc., whose organs appear to determine their destiny—unless indeed it is the destiny that determines the organs.

Quite recently the myrmecologists have discovered, or believed they have discovered, a still more unexpected kind of specialist: the ant-fireman. An observer to whom we owe more than one interesting and conscientious contribution to the science, Mme. Marguerite Combes, the daughter of the great botanist, Gaston Bonnier, in a note published in the *Journal de psychologie normale et pathologique*, and in certain communications made to the Société Entomologique, summarized and completed in a paper which appeared in the *Revue des Deux Mondes* for April 1, 1930, declares that she has on several occasions seen a troop of *Formica rufa*, in the enclosure of the Laboratoire de Biologie Végétale at Fontainebleau, attack and

extinguish, by emissions of formic acid, sometimes in ten seconds, sometimes in as many minutes, a lighted taper placed upon their nest. The first ants to attack the flame often perish, the victims of their devotion to duty. In other experiments the ants, in the presence of witnesses, extinguished a large night-light, such as is used for warming food. These experiments, when repeated, gave always the same results; but it must be added that this ability to extinguish a flame seems to be exceptional; indeed, of six nests of *Formica rufa* established in the enclosure of which Mme. Combes speaks, only one definitely possesses it and retains it year after year.

At first sight the thing seems incredible. How can we admit that ants have any notion of fire? Normally there has never been such a thing as fire in a formicary. For that matter, fire could only be the result of lightning, or of a conflagration involving forest or plain, so that the ants could become acquainted with it only

by perishing in the flames; they could never have the opportunity of acquiring an experience with fire.

Nevertheless, it is possible to explain their behavior. It has often been observed that when they are confronted, for example, with a drop of a liquid whose odor inconveniences them, they throw pellets of earth or débris over it until it is absorbed. Is it not an analogous reflex —if we can give the name of reflex to an action so plainly intelligent—which makes them act as they do in the presence of a flame?

Mme. Combes is of the opinion that her *Formica rufa* have gradually become familiarized with fire owing to the cigarette-ends frequently thrown on to their nest. It is quite possible that this very simple explanation is the most acceptable. In any case, it does not detract from the ingenuity displayed by the formicary. If such facts were definitely confirmed and classified we should have to regard them as the most important and the most disconcerting revela-

tions which have hitherto been afforded us by animal psychology.

Formica rufa is very abundant in the woods of Peira-Cava, which lie above Nice, near the Italian frontier, running up to an altitude of five thousand feet. One can hardly walk twenty paces without coming upon one of their mounds of pine-needles, which are twenty to thirty inches in height. Here I recently made some thirty experiments, with candle-ends of different thicknesses, tapers, and wax night-lights.

A candle-end, about an inch in length, when lighted and placed on the summit of the nest, was at once furiously attacked by the first workers to perceive it; the alarm spread, and presently an agitated crowd of ants formed a circle round the area, about the size of a half-crown, in which the flame—to their eyes enormous, being three or four times the length of their own bodies—gave off an intolerable heat. Every moment a worker, with lowered head,

flung herself into the infernal circle. One heard a crackling sound, and the insect's body curled up and burned like a match. Others, in increasing numbers, followed this heroic example, or stuck fast and died, asphyxiated or boiled alive, in the sheet of molten wax which was gradually spreading round the candle-end. Finally the flame was extinguished spontaneously, when the wick, deprived of support, drooped and fell over. But I could never see that the ants helped in any way to extinguish it. I must, indeed, confess that I do not see how they could do so, since before they could get near enough to do anything they perished, roasted or asphyxiated. One ought perhaps to experiment with a very small flame, in proportion to their own size; but then this flame would be so fragile, so precarious, that by brushing past it or running over it they might extinguish it without any definite intention of so doing.

One thing, at all events, I did observe, and that was their reckless and superhuman heroism.

Others will doubtless make more conclusive experiments. I discontinued mine because to me they seemed to be uselessly cruel.

I am told that in certain forests, and notably in those of Compiègne and Fontainebleau, *Formica rufa* is becoming increasingly rare. The collectors of ants' eggs, or rather cocoons, which are used in the rearing of pheasants, are waging a merciless war on the species. It is high time that the law intervened, as it has in Prussia, in order to save this fine ant, which has been called "the policeman of the forests," from complete destruction. A conscientious myrmecologist, M. Robert Stumper, has calculated that a single nest of *Formica rufa* destroys every day more than fifty thousand noxious insects: hymenoptera, microlepidoptera, caterpillars, etc.

IX

Since at the end of this chapter we have rather wandered away from our agricultural

ants, we may permit ourselves a further digression.

When we see ants bustling about the nest whose peace we have troubled, and transporting, with incredible ease, up and down the most precipitous gradients, cocoons twice their own size, or carrying and arranging, with the greatest ease, with the tips of their mandibles, so to speak, pine-needles or fragments of wood which to us would represent beams or posts which two or three men could barely handle, we believe them to be endowed with a muscular force which hitherto we have estimated to be eight or ten times as great as our own. It is possible that we are wrong. I have recently received a communication from a Swedish engineer which throws a different light on the subject.

Take a man six feet in height. This man can without difficulty carry a ball of iron some 8 inches in diameter, weighing about 80 pounds. Reduce this man to one thousandth of his size;

he will be only a fourteenth of an inch in height, and the weight of his ball, reduced in the same measure, will be about an ounce and a quarter, while its diameter will be four-fifths of an inch. From this it would seem to follow that man, reduced to one thousandth of his size, would be incomparably stronger than the ant, since he would be able to carry an object ten times his own size.

These calculations have been sharply criticized; and as a matter of fact the engineer has been guilty of a flagrant error. He applies a linear reduction to a weight: that is to say, to a volume. In the example which he suggests the reduction to one thousandth gives a homunculus one fourteenth of an inch in height carrying a sphere one hundred and twentieth of an inch in diameter—a mere speck of metallic dust, barely visible to the naked eye.

This flagrant error is interesting, because it is the error into which we all instinctively fall when we see ants carrying objects three or four

times their own size. In multiplying their size and the presumed weight of the object by a thousand we make, inversely, the same erroneous calculation. We do not think of the insect's weight--as a rule we are ignorant of this —but thinking only of its size, as this is all that we can see, we multiply or divide one value by another with which it has nothing in common. It is the weight of the man that we ought to divide by a thousand: which would give us a man weighing from three to three and a quarter ounces. What would be his height? Here, as one of my correspondents observes, mathematics is at a loss, for the substance of the man is not homogeneous, nor his structure homothetic.

The problem, moreover, is more complex than one would suppose. In 1922 Victor Cornetz published an article on the subject in the *Mercure de France* which explains the matter better than I can. He observes that the weight of the ant is in proportion to the cube of its linear dimensions. "An ant one third the size

of its fellows is twenty-seven times lighter; now, its muscular strength is not diminished in the same proportion; it depends on the square of its linear dimensions; that is, the small insect is 'absolutely' only nine times weaker than the large one. One of the dimensions of its muscles—their length—does not enter into the evaluation of its strength. The smaller the creature, provided its proportions remain about the same, the more advantageous is this relation of the weight to the cube of the linear dimensions, a relation which is of prime importance in our argument; and the larger the creature, the greater the disadvantage."

Yves Delage (in the *Revue Scientifique* for 19 July, 1912), who quotes Victor Cornetz, shows that an ant which can carry a grain of wheat ten times its own weight would be able to carry only a hundredth part of its own weight if it were enlarged to a thousand times its present size. It would then be a hundred times weaker than a man or a horse.

PARASITES

PARASITES

I

ATTRACTED and detained by the comfort, abundance, warmth, and security of the nest, encouraged by a general mildness of behavior which one might take to be weakness or imbecility if it were not so often heroic or ingenious, the parasites of the formicary exist in bewildering abundance. At the present time we know of more than two thousand species, and incessant discoveries, above all among the tropical insects, are daily adding to this number. The study of these parasites, to which articles and columns have been devoted whose enumeration would fill five or six pages, forms one of the most crowded and fantastic chapters of myrmecology. I shall not linger over it here, save to cite a few observations which will

throw an indirect yet sometimes vivid light on the still very confused and bewildering psychology of the ant. Parasitism, for that matter, appears to be one of the fundamental laws of nature, one of her favorite methods; and Professor J. M. Clarke has found traces of it in the marine animals of the Cambrian deposits: that is to say, at the very beginnings of life. This discovery is not calculated to give us a very consoling idea of the moral nobility of our universal mother, but it is incontestable, and has a claim upon our attention.

Our ants, naïvely and rashly hospitable, keep open house; all are welcome to their table, so to speak; and they themselves set the example of parasitism by sponging on one another. A few species—but only a few, we must admit—live solely at the expense of other more obstinately honest and laborious races. I will not return to the case of the Sanguines, the Amazons and others of their kind; here we have a special sort of parasitism, or rather, a sort of

voluntary collaboration, in which the one species feeds the community while the other defends it. Passing over the dwarf *Dorymyrmex pyramica*, a comparatively inoffensive ant, I will mention the *Solenopsis fugax*, whose criminality is of the basest type. Living always underground, she is almost blind, and so small that she escapes the notice of the unfortunate insects who give her shelter; they neither see her nor detect her with their antennæ. She bores her tiny galleries in the partitions of the nests of larger species: amongst others, the *Formica fusca*. Choosing a propitious moment, she pops out of the wall, as in a grisly fairy-tale, quickly carries off an egg, returns to her lair, and then devours it undisturbed, for the victims of these incessant thefts cannot force their way into her narrow corridors. It astonishes us that these large ants do not take any preventive or defensive measures against these Lilliputian but pitiless ogres. Are they too busy, too wholly absorbed in their labors to realize what is happening? Does it

never occur to them to enlarge the corridors or wall up their entrances? The problem, I believe, has not yet been studied in an artificial formicary. At any rate, when we overturn one of these double nests we are still more astonished to find that it is the assassins who avenge themselves, biting furiously at the parents whose offspring they have massacred. Once more we have the impression of witnessing a drama enacted on another planet.

II

With the *Bothriomyrmex decapitans*, observed by Santschi, and adorned by a name as barbarous as her habits, we do not leave our own planet, but find ourselves in the early Middle Ages. Emitting an odor resembling that of her victims, as though nature had premeditated the crime that she commits, she takes advantage of this fact, on returning from her nuptial flight, in order to enter with impunity the nest of the *Tapinoma erraticum* or *nigerrimum*, a virtuous,

confiding and laborious insect. Very much smaller than the *Tapinoma*, but full of impudence, as though she were already wearing the crown, she rapidly makes her way to the chambers in which the eggs and larvæ are laid out, goes up to the peaceful queens, overpowers one of them, perching herself astride on her back, and proceeds to saw through her neck, between the base of the head and the pronotum. The head falls. Terrified, the other queens escape, with a portion of their subjects. The workers who remain faithful to their natal home adopt the intruder, who at once begins to lay. The autochthonous race gradually becomes extinct, and the nest of *Tapinoma* becomes a colony of *Bothriomyrmex*.

We must not judge the ants by such ferocious examples as these. Of the more than six thousand species which have been observed, there are not in all more than a dozen which never work, and live solely to the detriment of others. Let us admit that the proportion is a modest

one, and that among human beings it would be less flattering.

III

Although her biography is less dramatic than that of *Bothriomyrmex decapitans*, I cannot pass *Anergates atratulus* over in silence, for she is an insect of some celebrity in the annals of entomology. She is a parasite of a more bourgeois character: the type of the parasite by predestination. The queens of this species do not produce workers, but only females and males, who think solely of love, do no work, and are incapable of feeding themselves. Barely fecundated, still agile, and entering unperceived, one of these queens makes her way into the nest of a laborious race, *Tetramorium cæspitum*, and there, we do not know why, she is very favorably received. Being abundantly fed, her ovaries develop in an extraordinary fashion; she swells up like a balloon, or rather like a termite queen; she grows monstrous, and is incapable of moving, so that her maids of

honor have to carry her. Before long the nest is encumbered with her eggs, for she never ceases laying. The *Tetramorium* workers neglect their own larvæ for the benefit of this alien progeny, and sometimes even sacrifice their queens to the intruder. Why this preference, why this fatal aberration? Although Von Hagens was able to observe the same nest for several years in succession, and although such sagacious myrmecologists as Adlerz, Wasmann, Janet, Wheeler, Crawley and Forel have studied the insect, they have not yet found a satisfactory answer to these questions.

Other examples might be cited: notably *Formica microgyna*, a temporary parasite, discovered by Wheeler, and readily adopted by *Formica fusca;* in the end she supplants the latter, giving birth to a colony which retains no trace of its discreditable origin. "A perfect replica," adds Wheeler, "of certain human institutions, which, beginning with a timid and flagrant parasitism, acquire, in the course of the

centuries, an exuberant and insolent preponderance."

Other parasites, the *Platyarthrus*, which are sometimes of considerable size, and which, if they are not harmful, at all events perform no service, appear to have the singular gift of rendering themselves invisible to the eyes of the ants. Although they swarm in the nest, the ants pay no attention to them, and pass through the midst of them as though they did not exist. But the *Platyarthrus* are not relatives or allies; so their proper place is in the following chapter.

IV

This parasitism of alien species has other surprises in store for us, of the most unexpected and varied nature, and once more we seem to be transported into other worlds and other ages.

To begin with, I must mention, without entering into details, a legion of little spongers, petty profiteers, infinitesimal cheats and sharpers, who are sometimes persecuted if too im-

pudently dangerous and harmful, but are more often tolerated, even if they are a nuisance, and who live modestly enough on the débris of the nest, or filch a drop of syrup, or pass their time in licking up the nutritive secretions of their hosts. They are like larvæ furnished with legs, or crabs, or crickets, or shrimps, or lobsters, and are comparatively gigantic, since they are almost as large as the ants; and all this infernal menagerie swarms freely in the nest, and the busy and long-suffering ants raise no objection to its presence. They are even ready at all times to encourage the profiteering of these creatures. Thus, when *Atulura formicaria*, a fat, ugly, conical maggot, sees that two workers are facing up for regurgitation, it rises up between their mandibles in order to intercept part of the regurgitated drop. Far from maltreating the intruder, the ants politely wait until it has partaken of its share. They behave in the same way to the inexplicable *Antennophores*, which have been studied by Janet, Wasmann, Karárieff and

Wheeler. These parasites, which I have already mentioned in *The Life of the White Ant*, are carried by a great many *Lasius mixtus*. They are a kind of louse, proportionately enormous, for they are often as large as the head of their victim. As a general thing three will be found on the same *Lasius;* they install themselves methodically, one under the chin, and the other two on either side of the abdomen, so that they shall not hamper the movements of their protector, who tends and feeds them as though they were her own offspring.

I must add, however, that some of these fantastic guests render certain services: they consume the ordures of the nest, or rid their patrons of the microscopic mites which prey upon them, or make war on the invisible vermin that swarm in the porous galleries.

V

But the bulk of the army of parasites consists of coleoptera of all shapes and sizes, which

have had time—since we find them already extant in the fossil amber—profoundly to modify their organs, in order to adapt them exclusively to the parasitic life which they have been leading for millions of years. Their antennæ, for example, are thickened, in order to solicit regurgitation more effectively, or to serve as handles to facilitate transport; for these parasites are extremely lazy, and never walk, but make their adorers carry them. The tongue is shortened, the mouth is enlarged, and the thorax is covered with hairs of a special nature, in order that the aromatic and etheric secretions which constitute the magical charm of these strange acolytes shall be more generously diffused. Some of these coleoptera—the European *Atemeles* and the American *Xenodus*—even choose their holiday resorts, and have two addresses, spending the winter with the *Formica* and the summer in the nest of the *Myrmica*.

Already we know of three or four hundred species of such parasites, though little is known

as yet of those which exist in tropical countries. The ants regard them with such adoration, such passionate devotion, that they give the larvæ of their favorites even more attention than their own, and in the event of danger these larvæ are the first to be carried to a place of safety. These parasites are the sole blemish, the one great vice of the virtuous, chaste, austere, sober and laborious republic, and sometimes they constitute a veritable social scourge, as deadly and as fatal to the race as the alcoholism of human beings. They would be the infallible cause of ruin and death in every colony they infest, were it not that a fortunate chance, or a providential error of nature, has restricted their powers of proliferation. Firstly, not content with regurgitation, they commonly devour the offspring of their hosts; and secondly, the workers, whom they demoralize, seducing them to a sort of etheromania, no longer give the royal larvæ the meticulous attentions which they require; so that these larvæ, being insufficiently

nourished, produce only pseudogynes—that is, degenerate and infertile females. Under these conditions, then, it would seem that certain races, notably the Sanguines, which are especially given to associating with these disastrous pensioners, ought to have disappeared; whereas, on the contrary, they are more numerous than the other species, and are found in all parts of the world. It was Wasmann who discovered the explanation of the enigma. The Sanguines treat their own larvæ and those of their housemates in the same fashion. When they are on the point of molting and becoming nymphs, they bury them all together, and leave them to spin their cocoons. When the nymphosis has been accomplished they exhume them, wash them, and lay them out in the nest. But the nymphs of the coleoptera perish if they are exhumed after nymphosis, so that the only ones to escape death are those which the workers have been unable to find.

VI

This curious fact has given rise to much discussion in myrmecological circles. Wasmann, a Jesuit, sees in it a proof of the ants' lack of intelligence, and a manifestation of the Divine wisdom which maintains the equilibrium of nature. Wheeler, supported by Hobhouse, the author of *Mind in Evolution*, declares that the absurdity of an ant who feeds the parasites that destroy her offspring is not greater than that of a mother who thinks to assure the happiness of her daughter by selling her to a multimillionaire, an inquisitor who burns a heretic in a spirit of Christian charity, or an emperor who, in the name of civilization, orders his troops to give no quarter. It is a fact that if we were to compare our blunders, our imbecilities, and our illogical absurdities with those of the ants, the comparison would not necessarily be to our advantage. Nevertheless, I think we can defend the ant's behavior without resorting to ex-

tremes. It is natural enough that the unsuspecting Sanguines, in attending to the needs of thousands of larvæ, all very much alike, should treat them all in the same fashion. It is asking too much of her to demand that after the sacrifice of the parasite nymphs she should realize her mistake. Men have committed more serious mistakes century after century, and have not yet corrected them. For that matter, we may believe that experience has not as yet engraven itself upon the instinct of the insect because there was an occult but important reason why it should not be so engraven. Have we not already seen, for example, in the case of the mushroom-growing and pastoral ants, that the insect is as capable as we are of fixing the lessons of the past in its atavic memory when these lessons are really useful?

VII

It must be added that nature does not always thus benevolently provide the remedy as well as provoking the evil. The excessive tolerance

of certain colonies, above all when the parasites are congeneric, sometimes leads to their extinction. In the chapter entitled *The Secret of the Formicary* I spoke of the *Wheeleriella Santschii*. By means of antennal caresses this ant wins the favor of the *Monomorium Salomonis*, which prefer her to their own lawful queens, whom they proceed to suppress. After which she begins to lay her eggs, and replaces the original race by her own. But as the workers of *Wheeleriella* do not work, the whole usurping colony ends by dying of inanition in the very climax of its triumph. We find analogous examples among other races of the *Anergates*, as the entomologists call them: that is to say, without workers. Fortunately for the future of the myrmecæan species, these races are rather feeble and by no means abundant.

We may note, in passing, that among the social insects the bee, thanks to her formidable sting—and perhaps also because she possesses only a rudimentary collective organ—is almost

exempt from parasites. The termite, on the other hand, more puritanical, more disciplined, assuredly less generous, less ingenious, less fanciful and less artistic than the ant, tolerates a small number only, which appear to be furnished with odoriferous glands.

VIII

In the midst of all these innumerable and multiform parasites, generally hideous, often dangerous, or at least of suspicious character, and always an encumbrance, the intimate life of the formicary must assuredly be very different from our own. It passes in a perpetual nightmare, in a frightful but perhaps a thrilling fairyland, in endless haunted underground passages, where specters and phantoms and apparitions more demoniacal than those of the temptation of St. Anthony issue from the walls, lie in wait at every corner, lurk in every corridor, invade every chamber, caressing but avid, a creeping, gallows crew, offering, in exchange

for honey, the equivocal pleasures of perfumes or noxious drugs. It is difficult for us to imagine what it would be like, on returning from our day's work, to find our home peopled by two thousand different monsters, each more hideous than the rest, and behaving as though they were in their own home, whose fixed and organic idea, whose sole *raison d'être,* was to live at our expense. While we are quite unable to understand it, we note the fact that the intelligent ant, far from purging her nest, as she could, at a single blow, of all this phantasmal circus, this ignoble and ruinous masquerade, actually favors and encourages it, takes pleasure in it, and regards it as an indispensable luxury, the reward of her toil, the ornament and the joy of her house; and the more intelligent, industrious, wealthy and intelligent she is, the more complete her complaisance, and the greater the impunity of her parasites. For that matter, her complaisance does not as a rule appreciably affect her prosperity, for the kindly *Formica*

fusca, more indulgent than any of her sisters to the fraternity of professional spongers, is even more numerous and more cosmopolitan than the Sanguine, who is herself addicted to the stupefying drugs of the coleoptera.

But we are not competent to understand the mystery. As I have said, our inner and profounder life, our only real life, does not revolve in the same direction. All our vices arise from egoism, instead of being the excesses of altruism. Those who are ruined by their kindness and tolerance are regarded as saints or madmen, that is, as abnormal. Of all the social animals man is alone in not being the victim of any parasite, that is, of any parasite of approximately his own dimensions, for the infinitesimal vermin to be found everywhere, even on the parasites of parasites, do not count. It would seem that being the parasite *par excellence*, the greatest parasite on earth, he has hitherto been able to hold the rest in respect or subjection. We have reserved for ourselves

alone the advantages of parasitism, and we exercise them only among ourselves; but the practice of the art loses nothing thereby. It is obvious that if we behaved as the ants do we should not hold out very long. They must therefore be very much stronger than we are, or their organs have been conceived on another plan, in prevision of the excesses of kindness of which they are guilty, for if we had been equally kind we should have disappeared in the dawn of our existence.

EPILOGUE

EPILOGUE

I

HERE, then, more or less, are the essential features of the life of the ants; a life incontestably superior to that of the bees, which is precarious in the extreme, cruelly laborious, marred by frequent sickness, and at best very brief; and also to that of the termites, a ferocious, incarcerated life, barbarous, furtive and merciless.

Let us suppose for a moment that our senses were adapted to the environment in which they delight, that our eyes loved the darkness, our palates the food, and our nostrils the odors which they prefer: what would a life of this kind mean to us, if all were enlarged to our own scale? Compared with our own, would it be more or less endurable, more or less futile, more or less explicable, more or less disheart-

ening? Unless indeed the discoveries or revelations, which the centuries yet before us may perhaps bring to humanity, should effect a singular improvement and transformation in our bodies and our souls; and without taking into account a survival that is becoming more and more doubtful, and promises of a future life which for thousands of years have been broken, I believe that the ant is far less unhappy than the very happiest of men. Her mother, when she founded her colony in the terror and torment of which we have had a glimpse, would seem to have paid once and for all the grievous tribute which we pay all our lives. The ordeal once endured, destiny makes no further demands, whereas the troubles of man are reborn with each succeeding day.

To begin with—and this is very important—her health and vitality are indestructible and unfailing. A decapitated ant will survive for twenty days, and keep on her legs till the last.

Her body, enclosed in a shell tougher than our thickest armor, is endowed with fibrous entrails and viscera, and its digestive functions—our own abominable blemish—are reduced to such a point, and are so perfect, that they leave hardly any residue. She is simply a bundle of muscles and nerves, and we cannot even conceive of the energy accumulated in her limbs. She is endowed with such an excess of power that—as Rémy de Gourmont has remarked—she ignores the laws of gravity, climbing and descending a vertical plane as though she were moving on a flat surface. She knows nothing of our epidemics and all our maladies. We do not even know when she is dead, so easily does she come to life again. Miss Field has made some rather cruel but convincing experiments in this connection. Four ants out of seven returned to life after they had been a week under water. Others she compelled to fast, giving them only water on a sterilized sponge. Nine *Formica subsericea* survived for seventy to a hundred

and six days. A large number of ants were subjected to this ordeal, but there were only three cases of cannibalism; and on the twentieth, the thirty-fifth, the fortieth and the sixty-second day of their fast, when half dead of starvation, some still continued to give, by regurgitation, a drop of honey to those of their comrades whose condition seemed desperate.

They are sensible only to cold, which does not, however, kill them, but puts them to sleep, and enables them to wait for the return of the sun in an economical state of torpor.

II

Apart from the great natural catastrophes—frost, excessive drought, flood, famine and fire, which threaten all living creatures—apart from wars between peoples, which often end in adoption and beneficent alliance, the ant, dreaded by all, has few enemies to fear. Having entered her home, that subterranean refuge which must be enlarged to our human scale before we can

realize its advantages, she has nothing more to fear; for there she finds peace and abundance and perfect fraternity. Despite all the perturbations and abnormal stimulations to which I have subjected ants in artificial nests, it was necessary, before I could incite them to the beginnings of a civil war, to bewilder them completely, to make them utterly lose their heads, to inflict upon them trials which no human brain would have resisted. Normally, two ants of the same republic have never been known to fight, to quarrel, to lose patience, to forget their amenity. Whereas the queen bee cannot rest until she has massacred her rivals, the ant queens live in concord and treat one another as sisters. When the ants have to resolve on a course of action on which the fate of the community may depend: when they decide to abandon their home, to migrate, or to undertake some perilous expedition, they strive to convince those who do not share their opinion by antennal caresses, and above all by example. At

such times, as Michelet truly says—and this time he is guilty of no excess of sentimentality—they will carry off the recalcitrant ant, "who offers no resistance, and will transport her to the place or object appointed. In this case, when the thing intended is doubtless difficult to believe or explain, the auditor, being convinced, joins herself to the other, and both proceed to carry off other witnesses, who in turn do the same to others, in ever increasing numbers. Our parliamentary expressions, *to carry away the crowd, to transport one's audience*, etc., are by no means metaphorical in the world of the ants."

Unlike ourselves, the ant has the good fortune to be far more sensible to pleasure than to pain. Amputated or truncated, she does not deviate from her path, but hastens toward the nest as though nothing had happened. But if a sister solicits her she stops and shares with her the delights of regurgitation.

With us happiness is mostly negative and

passive, and is hardly perceived except as the absence of unhappiness; in the ant it is before all things positive and active, and seems to pertain to a privileged planet. Physically, organically, the ant cannot be happy unless she is giving happiness to those around her. She has no other joys than the joys of duty accomplished, which for us are the only joys that leave no regrets, but which most of us know only by hearsay. The transports of love, in which we think to surpass ourselves and escape from ourselves, are merely and essentially egoism concentrated or exasperated to such a point that it brushes elbows with death or annihilation—the very things that it seeks to annihilate. The ant knows other joys, which instead of contracting happiness enlarge it, multiply it, and lavish it upon her innumerable sisters. She lives in happiness, because she lives in all that lives around her, because all live in her and for her, as she lives in all and for all.

III

She lives, above all, in immortality, for she is part of a whole which nothing can destroy. Strange as this assertion may at first appear, the ant is a profoundly mystical being; she exists only for her God, and does not imagine that there could be any other happiness, any other reason for living, than to serve Him, to forget herself, to lose herself in Him. She is wholly steeped in the great primitive religion of totemism: the most ancient of all religions, the most widely distributed of all the religions practiced by man. At the root of all other religions, underlying all the gods, totemism is the earliest pursuit, the first conquest, by that which dies, of that which does not die. The totem was the collective soul of the tribe. Our remotest ancestors, in the words of M. Alexandre Moret, the Egyptologist, "believed their soul to be secure because it was bound up with the totem, that is to say, with an animal or vegetable species; a class of objects which could not *all* perish. On

the death of the individual, the totem, the immortal collective soul, resumed this parcel of itself which had emanated from it for the term of its ephemeral existence."

The ant, of course, does not tell herself these things—nor did our ancestors tell themselves these things—but they are the substance of her life; and some indefinable instinct, dispersed through all that breathes, whispers them in her soul. Her totem is the spirit of her formicary, as the totem of the bee is the spirit of her hive. For primitive man the totem was the spirit of his clan. In its place we have now nothing more than a few evanescent phantoms which will soon disappear in their turn. Nothing will be left us but our life of an hour, and we shall feel ourselves to be more and more isolated, less and less protected against death.

IV

We saw, at the beginning of this volume, that ants which were as civilized as the most civi-

lized ants of today, ants with herds of cattle and "luxury" coleoptera, are found in the Baltic amber: in other words, they already existed in the Oligocene and the Miocene periods, long before the appearance of man. For millions of years, then, they do not seem to have evolved in any perceptible degree. Why should this be so? Perhaps, as we have already said, because a few millions of years are not enough to make evolution perceptible. One can only hazard hypotheses, for traces of the proto-ant are lacking, just as traces of pre-human forms are lacking. But just as we still find, in certain islands, primitive men who live as those of our ancestors lived who were contemporary with the mammoth, so we still find a few belated species of ant which have not followed the general movement; notably the *Ponerinæ*, which are supposed to be descended from a more ancient type, belonging to the fauna of the Mesozoic or Secondary period. These last survivors of a species which became extinct in the immemorial

backwoods of time are hardly to be numbered among the social insects. Their colonies contain no more than a few dozen individuals; their stomach is not as yet divided and specialized. They are almost exclusively carnivorous, and they do not practice the essential act of the formicary: regurgitation. Their cuirass is stronger than that of the civilized ants, and they are equipped with a formidable sting, for since they live an almost solitary existence the dangers to which they are exposed are all the greater, and their association being somewhat precarious, their larvæ are capable of feeding themselves without the assistance of their parents.

It is, for the time being, very difficult to retrace the steps which mark the ascent from the humble *Ponerinæ* to the level of the higher ants, for our observations of the former—nearly all of which are Australian, just as, by a curious coincidence, the lowest of our savages are Australian—are still very incomplete. On the other

hand, between the Mesozoic period and the fossil amber there are no traces of ant life; but it was evidently in the immense and unknown period extending from the Secondary to the end of the Tertiary that the social life of the formicary was organized and developed, gradually replacing the individual existence, to become what we see it today.

Since we are not, like the ant, physically and irresistibly altruistic, we have evolved in the reverse direction. To collective immortality we have preferred individual immortality. But we are beginning to doubt if it is possible, and in the meantime we have lost the sense of the collective. Shall we recover it? The Socialism and Communism towards which we are advancing mark a step in this direction. But being devoid of the necessary organ, shall we be able to remain in the collective stage and prosper?

Of this first hope of collective immortality, whose remnants still glimmer like embers in the instincts and the thoughts of the fathers of

families, who live again, or continue to live, in their children, we may well ask whether it was not, after all, the best, the most securely founded, and the wisest, and whether one day we shall not have to return to it, when all the others have come to seem chimerical. It may be that we shall have to go even farther, very much farther, and resign ourselves at last to the cosmic immortality which is the only immortality that is indisputably and infallibly certain, and which we do wrong to confuse with the immortality of nothingness, which cannot exist. But when shall we be of a stature to accept it without despair?

V

One might say that nature does not know what she wants, or rather, that she does not do what she wants to do, that someone or something restrains her hand, lest she should do too well. The old Scandinavian legends tell of the time when Satan still reigned. Has that time

returned? Or, if not nature, is it a demiurge, or one of our innumerable gods of old, Ormuzd or Ormazd, for example, the father of light and of the little good that we enjoy, as the Persians believed, who is thwarted by Ahriman, the lord of evil and of nothingness? It is an explanation to which it may be we shall have to return by another path than that of Christianity, for all things seem to be expiating a crime which no one has committed, since He who punishes the crime is alone responsible.

So soon as we posit questions which go beyond the poor little circle, no bigger than a plate, within which our lives are passed, the replies are inevitably uncertain, stammering, primitive and contradictory; they have made only a few childish advances since the beginnings of all the religions and philosophies. Our voice is confident and peremptory, our thought unhesitating only when we are thinking or speaking of our poverty, our little passions, our petty vices, and our meal-times.

Did the Unknowable that leads us, not wholly certain of its direction, choose to make three experiments, on the termites, the ants and the bees, before launching on time or eternity man, its final thought, and the latest comer among the animals? Can it be that we are the fourth trial, and very probably the fourth unsuccessful experiment? Is it possible to deduce, from the three previous experiments, any presage of our own fate?

It is a question that we ought to ask; for we ought to interrogate all things. It would be best, of course, to address ourselves first of all to our own electrons, for they are as old as the worlds. They would tell us everything, since they must know everything. When we speak it is they who are speaking, but they are silent in respect of all that we are not able to understand, or have not yet deserved to understand. In default of these let us turn to those inhabitants of our earth which are most like ourselves: to our social insects. We have no other point of

reference. Here, in its triple form, we find the sole analogy, the sole counter-proof, the sole prefiguration. This mirror with a triple face is hitherto the only one into which we can look for an image of our destiny. Small as are the actors of these dramas, they have their weight and importance, for we know well enough that in the infinite in which we all have our being size is of no account, and that the events which unfold themselves in the heavens obey the same laws as those which come to pass in a drop of water.

VI

Let us leave, for the moment, the termites and the bees, which are part of the same problem, and consider the ants. They set out from the *Ponerinæ*, and they have arrived at the stage in which we find them. How far will they go? Are they at their apogee, or already in their decline, as we might fear when we consider the morbid and alien ferments which the "luxury"

parasites are sowing in the best of their republics? Have they a different future before them? For what are they waiting? Millions of years have passed, and have counted for nothing; and so there have been milliards and milliards of lives and deaths which have counted for nothing. But what, then, does count for anything? Have they reached their goal, and what is this goal? If the earth, nature, the universe have no goal that we can perceive, why should they have one, and why should we? To be born, to live, to die, and to begin all over again until all things have disappeared: is not this enough? Someone opens his eyes in the night, sees a corner of the earth, an expanse of sea, a few stars, a human face, and closes them again forever. What cause has he for complaint? And is not this what happens to us? Even though it all lasted but a second, was it not better than not to have been?

What purpose have the ants served? What purpose do you think we ourselves shall have

served when we have reached the summit of the curve? None: save that we shall have permitted a few physical phenomena, which we call spiritual when they occur in our brain, to repeat themselves indefinitely, and to form themselves, at most, into a few different combinations, none of which will be final, none of which will lead to anything that has not already been.

VII

Lastly, whither do they go, what befalls them, what becomes of them when they are dead? Why smile at these questions when they are asked of insects, and take them seriously when they relate to man? Is the difference between us so very great? At every step we have the presentiment of their intelligence, and before we can refuse to admit it, we have to rebel against the evidence. We are no longer confronted by stones or vegetables, or beasts which are the slaves of instinct, but by lives which only a transparent membrane barely divides from our

own, for in many particulars they come very near to being our equals, and of these mysterious particulars we, in our ignorance, are but sorry judges. Can a little more or a little less cerebral activity change from the very foundation the laws of the universe, of justice and eternity, award immortality, or render it forever impossible?

There are some things that we find very difficult to admit. That there is not forming, in space or time, a sort of reserve in which the fruits of all these experiments, of all these efforts, of all these struggles against evil and want and suffering and imbecility and matter may accumulate; that one day all will be lost and wasted, that all will have to begin over again, as though nothing had ever been accomplished; that while the evil aggravates the ills of all and is harmful to all, the good changes nothing and profits no one.

Is the great sign that divides us from all that breathes, our discontent? Do we not ask too

much of a planet of the tenth, indeed of the ten-thousandth order? It does what it can, it gives what it has. But how do we know that the other beings that people it do not complain as we do? Are we alone in hoping that there may be something better? Is it this thought that sets us apart? We may well ask ourselves whence it can have come to us, because we have never left this earth of ours, nor known other standards than those which it offers us. Can the thought which judges and condemns be formed by that which it judges and condemns? In any event, since we have it, and since it differentiates us from all that surrounds us, let us not neglect it, for it is without a doubt the only thought that comes to us from beyond this earth.

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